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# MobileMarket

## The Social Advertisement Network

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# Abstract

In spite of the technological advances introduced lately into mobile phones, modern society still utilizes these appliances for the basic services of text messaging and voice calls. The ubiquitous nature of handsets is propitious for the development of innovative services that take advantage of the idiosyncrasies of the mobile environment.

In order to examine the opportunities that new technologies bring, the thesis introduces a case study where a secondhand advertisement service for mobile phones (MobileMarket) was developed and evaluated. A prototyping approach was selected to perform the development and an ethnographic approach was chosen for the evaluation. The overall research question of the study is: *"How can mobile applications that will succeed in contemporaneous society be developed?"*

Based on the analysis of related literature and systems, the development of MobileMarket, and empirically collected evidence from the evaluation of the service, the major findings of the study are synthesized in a *taxonomy* for mobile services, a set of *design guidelines* for mobile developments, as well as *recommendations and requirements* necessary in order to produce successful social mobile applications.

Keywords: *Informatics, Mobile Informatics, Mobile 2.0, Social advertising.*

*to my father...*

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# 1 Introduction

## 1.1 Background

Emerging technologies and new features have been incorporated lately to handheld devices, specifically to mobile phones. The most notorious examples of these technologies and features are wireless networking (WiFi and Bluetooth), increased computing power (processing speed and memory capacity), improved interaction means (bigger and better quality touch-screens), tied together with longer power autonomy. (Souza, 2006).

Novel applications are taking advantage of these capabilities funding a cutting-edge paradigm denominated mobile 2.0 (Appelquist, 2006). The achievements inside the discipline not only include the arrival of the web to the mobile devices, but also the proliferation of native applications that facilitate the interaction among different users and their environment in a ubiquitous way (Holmquist et al., 2007). It became especially possible as consequence of the implementation of carrier-free wireless networks that allow inexpensive communications among different peers situated in the same vicinity through the creation of casual social mobile networks (Frattasi et al., 2006).

Nowadays, when a person wants to sell something, the possibilities are basically to announce it on the classified ads section in a newspaper or to put a message on the Web, through social sites such as Preloved, Craigslist, or eBay. Even though these services have been available for years demonstrating that they operate successfully (people actually buy/sell products), they suffer of some pitfalls. One important matter is the audience of the advertisements that is normally unlimited and covers the whole world (eBay, 2006). The thesis presents a case study focusing on that issue, providing a way to limit the scope of the advertisements to peoples' physical surroundings. A novel mobile 2.0 service is designed, implemented, and evaluated trying to acquire valuable knowledge about how the actual mobile environment is prepared for the inclusion of new ways of social interaction.

More specifically, the designed mobile 2.0 service allows users to introduce short classified announcements in their mobile phones describing each product that they want to sell or buy. Once doing their habitual daily duties, spontaneous Bluetooth ad-hoc networks will be created with other users in the surroundings, exchanging

automatically their advertisements. This unprompted trade will be performed depending on each actor's interests, previously configured on their own devices. In addition, a way to contact the person selling the goods is provided in each received advertisement, in order to provide the potential customer access to further information. Hence, the designed system does not focus on selling goods, but instead on their publicity and propagation in the users' habitual environment.

## 1.2 Research problem

The main objective of the thesis was to reveal and evaluate the status and future opportunities of the mobile 2.0 discipline. To achieve this goal, a case study was presented carrying out the design and evaluation of an innovative mobile 2.0 service. Developing a social mobile system was expected to elicit sufficient knowledge about how propitious are nowadays most extended mobile technologies (regular mobile phones) for new ways of interaction. Additionally, evaluating the generated application, it was expected to explore the social degree of acceptation of mobile 2.0 services, and propose ways to improve its situation. Abstracting the introduced problem, the next research question is at issue:

*"How can mobile applications that will succeed*
*in contemporaneous society be developed?"*

To be able to answer the question fulfilling the objective, the research question is concreted in more affordable inquiries. Therefore, the next question statements have been identified:

*"What technological enhancements*
*are necessary in mobile platforms?"*

*"What design implications are likely*
*to follow to develop mobile services?"*

The first inquiry explores available technologies that may be utilized in order to support the creation of innovative social mobile services. To answer this question, the previously commented mobile 2.0 application is designed and implemented. In addition, after its evaluation, a generalization is tried to be established finding out how available and extended are the required technologies in nowadays mobile phones.

The second inquiry regards to the appropriateness of mobile 2.0 developments for their social use. Evaluating the implemented artifact in a small but representative sample of the population, it is expected to obtain insights of how applications can be developed in order to be more suitable for social mobile use.

In the end, it was expected to elicit sufficient knowledge about the use of innovative mobile technologies and applications. As outcome, the thesis collaborates to the development and maturity of the theories inside the brand-new mobile 2.0 discipline, and suggests a set of guidelines for forthcoming social mobile applications. Therefore, based on evidence from the empirical study, the contributions of the thesis include:

- Providing new insights into the mobile 2.0 field.
- Drawing implications for the design of new mobile services.

## 1.3 Report outline

The thesis is structured as follows:

- **Theoretical framework:** A review of the related literature is carried out, introducing theories that had influenced on the study. After that, an analysis of the related work is performed, commenting previous developments within the field.
- **Research methodology:** An introduction of the methods utilized in order to answer the research question is provided, introducing both the design and evaluation methods.
- **Design method**: The method followed for the software development process is presented, described, and justified.
- **Design and implementation of the prototype**: Results of the design and implementation of the prototype are presented. An initial analysis of requirements is performed, detailing the top-level architecture of the system and the technologies involved.
- **Evaluation method:** The method followed to evaluate the prototype is explained, describing how the study was carried out. The generated prototype is presented as a case study that is assessed by the users. A qualitative research

method was utilized to collect relevant information, approaching the field through ethnographic techniques.

- **Results of the evaluation:** Results of the ethnographic approach to the field are presented, showing collected data from the evaluation of the prototype.
- **Discussion of the results:** The results of the evaluation are assessed and interpreted, giving possible reasons for their occurrence. Additionally, an evaluation of the utilized methods is performed to determinate the validity of the study.
- **Conclusions of the study:** Final thoughts after discussing the results of the study are presented, including possible improvements and future work.

# 2 Literature review

Next subsection deals with informatics, the scientific discipline within which the study was carried out. After that, the mobile nature of the field is presented with mobile informatics. An introduction to the web 2.0 social contribution to the field is explained, culminating with the introduction of the mobile 2.0 paradigm.

## 2.1 Informatics: Designing information technology use

The term informatics and its connotations have changed since the German computer scientist Karl Steinbuch first coined it in late 50's (Steinbuch, 1957). Etymologically, it is accepted that the term origins as consequence of the combination of the words information and automatics (Mikhailov et al., 1967). So a preliminary definition can be "automatic information processing". In some countries, the term has been kept wide and is wrongly used as a synonym of computer science. The main characteristic of computer science is its highly mathematical and logical background. In contrast, informatics addresses the research aspects, methodologies, and organization of computing related disciplines. It also includes the study of the use of information technology (IT), and the interaction of technology with human organizational structures (Malcom, 2002).

Despite of the broad acceptance of the term informatics, Nordic countries and especially Sweden, have borrowed the term with a slightly different connotation. According to Bo Dalhbom in "The New Informatics" (Dalhbom, 1996):

> *"...it can be described as the theory and design oriented study of information technology use, an artificial science with the intertwined complex of people and information technology as its subject matter."*

Dahlbom stresses the need of taking into account not only the social aspect of IT, but also the actual design of its use. This interest in the design, aims to change and improve the use of IT, helping the creation of innovative artifacts that would successfully be used in the real world. The main objective for Dalhbom is to attain a better understanding of the world, designing as consequence original solutions that could improve or even change the way current habitual tasks are executed by people.

In the same way, Rob Kling gives the following definition for what he denominates "Social Informatics" (Kling, 1999):

> *"…the interdisciplinary study of the design, uses and consequences of information technologies that takes into account their interaction with institutional and cultural contexts."*

Kling's definition sounds practically the same as the one given by Dahlbom. He also comments the design centered study, the uses of information technology, and the social aspect that it implies. For Dahlbom, the name "social informatics" sounds too much like a social science, without the design orientation, which is important in the informatics discipline. However, it is not relevant for the study how the discipline is called (simply informatics in opposition to computer science might be adequate), as long as the social use of IT and the design oriented of its subdisciplines are addressed while performing research in the field.

## 2.2 Mobile informatics: Awareness of the dynamic context

One of the cutting-edge subdisciplines inside the field of informatics is mobile informatics. As introduced by Dahlbom and Ljungberg (1999), mobile informatics focuses on theories and services regarding mobile IT use. In their work, they stress the importance and necessity of performing more empirical work when designing services under the rules of mobility.

The expansion of Internet started what is called the "first IT revolution" in the middle 1990's. The instantaneous access to information reached as consequence of improvement of telecommunications brought unexpected consequences to the work and leisure habits of the entire society. It is said that the arrival of mobile technologies is starting the "second IT revolution" (Holmquist et al., 2007). Even though the outcomes of this new revolution are yet to be determined, they will not be unnoticed. Nowadays, an important development of mobile devices, including new hardware technologies that produce new possibilities in software developments, and their slowly but rising adoption by modern society are leading to a new way the social interaction is performed.

Mobile phones, as the best representative of the new wave of ubiquitous devices are just the beginning of what is yet to come. Mark Weiser, considered as the father of ubiquitous computing (sometimes called ubicomp), predicted an eventual future where technology is finally integrated and diffused with the environment, facilitating people's habitual tasks in unimaginable ways. This is what he called *age of calm technology* (third IT revolution?), where computations are performed with no conscience by human beings. (Weiser, 1991).

However, society still has a high dependency on stationary computers in order to accomplish daily tasks. This fact has influenced on the way new mobile applications have been designed. Researchers and developers have stuck in that "desktop thinking" forcing the creation of reduced versions of traditional applications. Only recently, a new conscience has emerged in research studies, culminating with new mobile informatics theories. The aim is to design innovative mobile IT solutions for the real world. Moreover, rather than going on about developing information systems, the discipline has been defined in terms of using mobile IT. (Dahlbom & Ljungberg, 1999).

Furthermore, the objective in mobile informatics is to create new mobile services from scratch, instead of trying to adapt existing methods (or applications) that have been designed for stationary computers. The idea is to take advantage of the richness that the mobile environment provides. In order to achieve this goal, new theories and methods need to be developed. Kristoffersen and Ljungberg (1998), suggest a framework to design mobile IT use. Their model is based on empirical studies of nomadic work, explaining the particularities of the mobile setting through the terms *environment* and *modality*. Environment is defined as the physical and social surroundings, while modality signifies patterns of motion. (Kristoffersen & Ljungberg, 1998).

They also specify different types of modality that can be found: *Wandering*, *traveling*, and *visiting*. Wandering represents the activity developed in a local environment, while traveling corresponds the process of moving from a setting to another, and visiting stands for the action of moving inside a specific environment for a short period of time. (Kristoffersen & Ljungberg, 1998). The framework provided by Kristoffersen and Ljungberg establishes the first tangible approach to design mobile IT use.

In addition, while designing a mobile service, it is needed to take into account the intrinsic constraints that the mobile setting entails. Satyanarayanan (1996) establishes a comprehensible classification of the common pitfalls encountered while in the mobile landscape:

- Mobile elements are resource-poor relative to static elements,
- Mobility is inherently hazardous,
- Mobile connectivity is highly variable in performance and reliability,
- Mobile elements rely on a finite energy source. (Satyanarayanan, 1996).

The first constraint defined by Satyanarayanan refers to the processing power, memory capacity, and ergonomics. These issues will not be attenuated only when mobile hardware provides the needed performance and capacity, but also when mobile services become inherently mobile (rather than adaptations of the desktop computers ones). Regarding the threats that can be found in the mobile environment, such as physical damage, loss, thievery, etc., a compromise is unlikely reachable from the software perspective. About the connectivity issue, it is expected that mobile devices will obtain the necessary communication capabilities as consequence of redundancy on different wireless networks (GPRS, UMTS, WiMAX, WiFi, Bluetooth, and so forth). Last but not least, the energy constraint is probably the most difficult to be solved. Relying on that hardware is getting more efficient with a consequent power consumption reduction and capacity of the batteries is increasing, devices autonomy will get longer. Nevertheless, the only variable that software designers can play with, is creating artifacts that minimize the need of superfluous communications, making connections as efficient as possible. (Satyanarayanan, 1996). All these pitfalls should be taken under consideration while designing mobile services, otherwise the resulting products will not be successful in the real world.

When doing research in mobile informatics, and regarding the evaluation of mobile artifacts, Alexandra Weilenmann (2003) proposes four approaches in order to capture the use mobile interaction. These approaches can concisely be described as follow the actors, follow the technology, study a place, and study the virtual communication space. The aim is to capture naturally occurrences of mobility depending on the characteristics of the appliances under study. By means of utilizing customized

qualitative approaches, valuable knowledge about the use of mobile artifacts might be obtained and used to improve the way they are designed. (Weilenmann, 2003).

As alluded above, the final purpose of mobile informatics is the contribution to innovation within the mobile IT field. This objective needs to be achieved trough the focus of the studies in the design of IT use. Since the study aims to collaborate with the evaluation of the status of the field generating a novel mobile artifact, the theories and methods presented in this subsection fit in the way the study is focused.

## 2.3 World Wide Web 2.0: The social contents

In the last luster a new revolution has occurred in the WWW. Applications that have been executed in the most famous distributed system called Internet, have changed the way the society experiments interaction. Some of the most representative examples of those applications are Blogger, del.icio.us, eBay, Facebook, Flickr, Google Maps, Myspace, Youtube, and so forth, which are denominated web 2.0 applications. The consequences of this revolution and its outcome might provide important insights that would benefit the evolution of mobile services.

Tim O'Reilly, who is credited with coining the term web 2.0, tries to define the technological change that web 2.0 has introduced, presenting the following definition (O'Reilly, 2005):

> *"Web 2.0 is the business revolution in the computer industry caused by the move to the Internet as platform, and an attempt to understand the rules for success on that new platform."*

In this definition, O'Reilly focuses on the business aspect of the web. In his article, he analyzes the technologies that have allowed this revolution to occur. He leaves for further discussion the consequences of the generalization of its use. Nevertheless, he provides a set of guidelines stressing the new social collaborative environment as the ultimate consequences of the web 2.0. He points that the new platform (as he defines it) provides the infrastructure, meanwhile the users create the contents.

After giving this definition, some controversy was generated around the web 2.0 circles. One of the participants of that discussion is Tim Barners-Lee, the creator of the WWW. Barners-Lee argues that web 2.0 is not a revolution. For him, there is

nothing new or innovative from the point of view of the traditional web (Barners-Lee, 2006):

> *"Web 1.0 was all about connecting people. It was an interactive space, and I think web 2.0 is of course a piece of jargon, nobody even knows what it means. If web 2.0 for you is blogs and wikis, then that is people to people. But that was what the web was supposed to be all along."*

Barners-Lee defends the web 1.0, arguing that it was already a social environment. For him, the new movement of the web is a natural evolution due to the technologies introduced lately. These newborn technologies allow performing new operations under the same traditional web rules. Regardless of how it is called (web 2.0 or simply web), it is clear that there has been a change in the use of World Wide Web. People have changed their role from being merely spectators to be active cooperators of the virtual contents.

As consequence of all the agitation produced, O'Reilly tries to be more specific in his definition, by adding: (O'Reilly, 2006):

> *"...Chief among those rules is this: Build applications that harness network effects to get better the more people use them."*

The most interesting consequence of the new add-on is the necessity of people's collaboration to generate websites that are successful. Therefore, the definition encloses the social aspect needed in the design of IT use, fitting with informatics theories. For O'Reilly, web 2.0 applications take advantage of the design of the new platform, delivering software as a continually-updated service that gets better the more people use it, consuming data from multiple sources, and providing their own data and services in a form that allows them to be used by others. It creates a network effect through an "architecture of participation" and goes beyond the page metaphor of web 1.0 to deliver rich user experiences. (O'Reilly, 2006).

To be able to understand the change produced from the web 1.0 to the web 2.0, O'Reilly explains that an evolution has occurred from the unidirectional communications from service providers to consumers, to the multidirectional communications from providers/consumers to consumers/providers. The web 1.0 was

determined by mere plain HTML informative sites, and dial-up Internet connections. The evolution to web 2.0 has been made possible by a number of convergent elements: the advance of communication technologies (broadband Internet connections…), improved client-side development (AJAX, CSS…), and more complex server-side applications (JSP, PHP…). All these new technologies allow the developers to create more interactive sites, creating the well-known social environments. (Appelquist, 2006).

O'Reilly provides some guidelines while designing web 2.0 applications. The design of each platform should be based on open standards and technologies that allow a universal access to its implementation. Intellectual property protection limits re-use and prevent experimentation. Following existing standards, and using licenses with as few restrictions as possible, allows evolution. Applications are increasingly data-driven, and therefore, collecting data from unlimited social sources yields better applications. Users add their own data to the infrastructure provided by the platform. Involving users implicitly and explicitly adds value to the application. Personal computer is no longer the only device to access Internet applications. Consequently, applications should be designed to integrate services across hand-held devices, stationary computers, as well as Internet servers. (O'Reilly, 2006).

The Web has shown to be a social medium with some years of experience on the field. In a different way, the mobile setting has shown to be intrinsic social. Consequently, the theories and guidelines learned from the web 2.0 can provide important insights to mobile 2.0. In the next section, an analysis of the new possibilities of taking into account that social aspect when designing services for the mobile environment is carried out, presenting a new paradigm of social interaction through the usage of mobile devices.

## 2.4 Mobile 2.0: Designing social mobile IT use

As commented in previous section, the web 2.0 started a revolution by establishing the web as a social platform. Although the same process has no reason to take place in the mobile field, there are signs that a similar occurrence is in spite of all occurring. Mobile devices are gaining persistent connectivity not only to Internet (through networks such as GPRS or UMTS), but also with other devices in their surroundings (through networks such as WiFi or Bluetooth). This connectivity aspiration provides new opportunities in the design of innovative mobile applications.

Daniel Appelquist (2006) tried to define the term mobile 2.0 for first time:

> *"The term of "mobile 2.0" can best be defined as the next generation of data services to mobile connected devices."*

Appelquist's explanation could not be more prudent. This is due to the controversy formed around the mobile 2.0 field. He leaves the definition as opened as possible, interpreting mobile 2.0 just as consequence of the technological evolution of nowadays mobile devices. In his article *What is mobile 2.0?*, Appelquist compares this evolution to the one that occurred in the change from web 1.0 to the web 2.0 (check previous section regarding web 2.0). As result, he expects the services offered in the web to become ubiquitous, consequently accessed from anywhere at anytime. (Appelquist, 2006).

Due to the inconcrete nature of Appelquist's definition, it has been misunderstood around the mobile 2.0 blogsphere, believing that it consists simply of accessing the WWW from hand-held devices. This is what in opposition, Ajit Joakar and Tony Fish (2006) name "mobile web 2.0". Mobile 2.0 is not just a mobile version of web 2.0, but actually more than that. It involves a new way to interact among different actors in any context (Campobianco, 2006). Indeed, since mobile 2.0 is not Internet dependent, social networks can be created in the users' surroundings, being these kind of services a the final aim of the developments in the field.

Trying to be more precise, and correcting his previous open definition, Appelquist defends that there is a danger that the definition of mobile 2.0 could get hijacked either to become synonymous with "web 2.0 applications and services brought to your phone" which is part of the story but not the whole. (Appelquist, 2006). Another pioneer of the mobile 2.0 discipline is Ruby De Waele (2007). The definition he gives tries to be more specific and self-contained:

> *"Mobile 2.0 is about creating value thanks to the ubiquitous nature of the mobile devices and the user's choice to mash personal & social content (address book, calendar, social networks) with personal context, such as location, and the ability to communicate and sync with other devices in an open environment."*

In this definition, De Waele takes into account not only the interaction through Internet (used mainly to store user's persistent data, making them accessible anywhere), but also the interaction with user's environment (either persons or objects). His definition includes social aspects taken from the web 2.0, adding the intrinsic nomadic nature of the mobile environment. For De Waele, understanding the potential of the mobile device as a connector of objects and people in the near future is a must. (De Waele, 2007)

Now that the movement is defined, and it seems to be started in small but expanding circles, an important consideration must be accounted: When will the real revolution take place? Mobile 2.0 is expected with flat fee mobile Internet access billing. It is the same as web 1.0, which exploded with flat fees after starting with modems. It is considered that the same will happen here. People using mobile 2.0 will first consists of enterprises (as in web 1.0), after which the mainstream will move when flat fee billing is available and cheap enough for everybody. This is something that network providers have to realize because they will make business with it. (Capobianco, 2006).

However, the omnipresent Internet connectivity should be just the beginning. The next step in this evolution would be what can be called *truly mobile services*, the ones that exploit intrinsic properties of mobility, such as access variability, ad-hoc meetings with other devices, context awareness, access to information dependent on geographical location, and positioning relative to other users or resources. (Holmquist et al., 2007).

Hence the establishment of mobile 2.0 can be considered as the arrival of collaborative and participative services to the mobile devices. This consideration fits perfectly into the intrinsic social aspect of the mobile setting. Therefore, the theories and guidelines learned from the web 2.0 can provide important insights to the mobile 2.0 field. Those new possibilities of bringing that social aspect to the mobile field will be explored, presenting a new paradigm of social interaction using mobile devices.

As commented in previous section, O'Reilly stresses the need of basing the design of the web platform on open standards and technologies, which allows a universal access to its implementation. These legal issues were an important point for the success of the web 2.0 that should be learned in the mobile 2.0 field in order to establish a standard platform on the highly heterogeneous landscape of mobile 2.0 platforms.

Connecting with the informatics and mobile informatics theories, the last objective is to design IT use (Dalhbom, 1996). Therefore when developing mobile 2.0 applications, the aim should be to design social mobile IT use (note the stress put in social), creating innovative services that connect the physical and social environments using the capabilities of digital appliances (Rudström, 2005).

## 2.5 Summary of the theoretical framework

Figure 1 below shows the context of mobile 2.0 related to the other fields and theories. It also describes the main and most interesting contributions of each field. As stated before, the development of the thesis is carried out within the mobile 2.0 discipline. Since it is a novel discipline in process of development, in order to improve its maturity, contributions from grown disciplines should be borrowed.

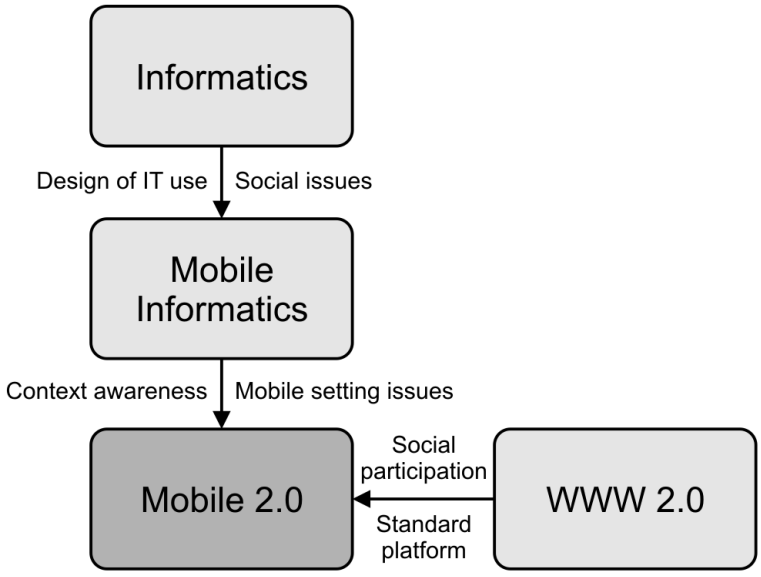


*Figure 1: Thesis context within the theoretical framework*

The contributions that informatics supplies to mobile informatics are the design of IT use and the social issues that accompany any technological development. In the same way, mobile informatics contributes with the context awareness needed to interact with the users' environment and the inherent characteristics of the mobile setting and its constraints. Last, web 2.0 provides the very important social participation nature, and the platform standardization highly necessary in the heterogeneous landscape of mobile devices.

# 3 Related work

In order to establish the knowledge presented in similar implemented projects, and possibly attain additional design guidelines that would strengthen the conclusions of the study, related services available at the moment in the market are presented and analyzed. To achieve this, first it is investigated how the secondhand advertisement market works, and what technologies and services are the most used. After that, a study of the actual mobile applications is carried out (trying to focus in mobile 2.0 services), in order to find out how they have being designed and how people use them.

## 3.1 Secondhand advertisement services

Analyzing how the secondhand trading is currently performed, we can attain insights of the most important functionalities needed by a field-related IT development. This will not only improve the way MobileMarket system is designed, but also redesign the conception of how human beings currently exchange goods. Secondhand advertising is an inherently social act. People connect to people using a way of communication or platform. Traditionally, newspapers have been the only means that people have used as non-technological platform. Nowadays, that platform has been replaced by online applications accessed through a web browser. The services for announcing ads online are web 2.0 social platforms, in consonance with the nature of the task of advertising. The natural evolution should bring this way of exchanging goods to the mobile setting, the most natural social environment for the moment. In the beginning of this section, a brief analysis of the traditional newspaper advertising is illustrated, to continue focusing in the analysis of more technological web 2.0 based services.

### 3.1.1 Newspapers: classifieds section

Printed newspapers have traditionally been the way people have advertised secondhand articles. In order to enable that, newspapers generally include a section called classified ads where they divide messages in categories according to the nature of the product. Classified advertising is usually textual based and may include a short title, a description, and a telephone number to call for more information. Newspapers normally charge the advertiser with a small amount of money, according to the needed number of words or lines.

An evolution of the secondhand advertising market is the introduction of Pennysavers. They are used in many free community periodicals in North America (typically weekly or monthly publications) that advertise items for buy or sale. Similarly, a free ads paper is a newspaper containing exclusively classified ads, usually grouped into an extensive set of categories.

The main advantage of advertising in newspapers is that people already know where to find the ads published in the area. The audience of the advertisements is totally determined in the moment it is published. For instance, local newspapers have a limited reach, being good for small non-problematic campaigns. Nevertheless, there are two disadvantages of using this method for publishing articles. The first one is that newspapers are non-free services. Both publisher and interested have to pay small fees. The second disadvantage is the longevity of the ads. Usually they are published only one day, disappearing from the scene when a new edition is released.

### 3.1.2 Craigslist

Craigslist was one of the first on-line classified ads sites. It started in early 1995 as a local classifieds site for San Francisco (USA), nowadays expanded to 450 cities worldwide. It contains a very simple HTML web based interface with textual navigation around the ads. A categorization depending on the area of influence of the advertisement is done according to the location of the announcement (from continent to city). Once the advertisements are filtered within the city of interest, a categorization depending on the type of announcement is presented. The options are either to add a new advertisement to a specific area, to read the ads belonging to a certain area (ordered by date), or perform searches inside the city or the category of interest. An interesting feature is that it is not necessary to be registered as user of Craiglists in order to publish new advertisements. Electronic mails may be sent to the server list, and a form is replied to the users' address in order to fill in the required information. Small images can be added together with a description, as well as a way to contact the publisher. Postings are nominated by readers, and are not necessarily endorsed by Craigslist staff. Consequently, there may be explicitly sexual, scatological, offensive, graphic, and tasteless advertisements. (Craigslist, 2008).

According to comScore (2006), Craigslist has grown to become the largest classified online source, with approximately 14 million unique visitors a month (table 1).

| | July 2005 | July 2006 | % Change |
|---|---|---|---|
| **Online classifieds** | ~25.487.000 | ~37.423.000 | ~47% |
| **Craigslist** | ~6.928.000 | ~13.804.000 | ~99% |

*Table 1: Craigslist evolution between 2005 and 2006 in USA (comScore Media Metrix)*

In general, it can be said that online classified sites have increased popularity between July of 2005 and 2006, gaining more than 10 million users (a 47% growth) in that year. Andrew Lipsman, senior analyst of comScore Networks comments (comScore, 2006):

> *"While online classifieds are not new, it appears that Internet users are really beginning to catch on to this phenomenon."*

The growth in the secondhand advertising market is very interesting considering the mobile 2.0 service developed in the study. It seems that people are using classified ads systems massively, mainly through the WWW. Already almost 40 million people only in USA are willing to sell and buy products by using the new capabilities offered by technologies, and the amount is increasing rapidly. These are potential users of services as the one designed in the study, once the mobile 2.0 field expands as the web is nowadays.

Craigslist provides the following advantages: It does not use per-line pricing models (typically used in newspapers), the audience of the advertisements can be specified (from city to continent or even worldwide), they do not have to suffer the pitfall related to the longevity of the announcements in newspapers (they expire and are removed from the system after 45 days online), etc.

### 3.1.3 eBay

eBay, founded in 1995 in USA, is a global online marketplace. It is considered as the largest auction place, currently present in 33 different countries, with 193 million registered users worldwide. Although eBay is well known for the auction format, its users may also buy and sell products in fixed-price format (similarly to Craigslist). The auction's way to sell products adds the capability of fixing dynamically the price of each item depending on the market. Users vote other users, regulating the quality of the market in a social way. The use of the system is not free, but the users pay a small percentage per announcement introduced as well as per sold item (eBay, 2006).

When analyzing the success of eBay, it is not interesting to know how the service gains popularity but instead to know the monthly unique visitors (without taking into account repeated visits of the same user), and the percentage they represent compared to the total Internet audience (table 2).

| | ***Unique visitors*** | ***% Reach*** |
|---|---|---|
| ***USA Internet Audience*** | *~175.653.000* | *~100%* |
| ***eBay*** | *~79.559.000* | *~45%* |

*Table 2: eBay visitors February 2007 in USA (comScore Media Metrix)*

According to comScore (2007), eBay receives almost 80 million visitors per month. This signifies that 45 percent of USA's Internet audience visits the auctions site at least once a month. Since this statistic represents only a month, the information cannot be taken as it comes. There are several factors that may influence this specific month making it a "good one" by receiving more visits than normally (one of this could be for instance that in February Valentine's day is celebrated). The information to be considered is that a large amount of people visits this auction place monthly, demonstrating how people are now, more than ever, willing to buy and sell secondhand goods using technological-aided means.

## 3.2 Mobile 2.0 applications

Traditional services such as the ones described in the previous section, have demonstrated to be successful in nowadays society. People use them massively to advertise goods, producing an evolution from the ads sections of newspapers to the web 2.0 announcements and auction services. As web applications did not replace the advertisements section of newspapers, mobile appliances will probably not replace the web ones. They all will survive in a multi-application landscape, providing a variety of alternatives to advertise products in different contexts.

As commented in previous chapter, mobile 2.0 is a very recent field of research and development of applications. Only a few tools are exploited commercially. Furthermore, only the most creative mobile 2.0 applications are succeeding commercially. The biggest effort has been invested in research services, trying to enhance the maturity of the field. In this section, some of the most representative examples of mobile 2.0 applications and services are analyzed and described.

### 3.2.1 Jaiku

Jaiku is a commercial application created in 2006. The services it offers are micro-blogging[1], availability status, location awareness, instant messaging conversations, and the possibility to retrieve and update shared social information from web 2.0 sources (del.icio.us, Flickr, Blogger, etc.) to other Jaiku users. Due to the utilization of the user context and on-line sources, Jaiku can be used only in mobile devices that are connected to Internet. Actually, Jaiku can be accessed from a stationary computers (as a regular web 2.0 application). In this case the context aware services (location awareness) are not available. While using it in a mobile device the users can update their profiles, and share their location (neighborhood, city, country) based on cellular network towers. Although in order to share that information, it is necessary to be connected to Internet. It also provides a way to share the personal data of the users themselves, based on nearby Bluetooth devices (Jaiku, 2007).

Jaiku is only compatible with Nokia S60 mobile devices. This give us insights of how difficult it seems to be to develop for the wide handsets landscape, and consequently limit the compatibility not only to certain brands of mobile devices, but also to specific models. Regarding the development platform of Jaiku, something to emphasize is the availability of an open application programming interface (API) that allows 3rd party developments. This is one of the mobile 2.0 requirements that O'Reilly stresses (refer to previous chapter, in mobile 2.0 description). Hence other developers may create their own implementations of the application, and offer innovative evolutions to the service (for instance, geolocalization based on GPS, possibility of exchanging small messages with the user's environment, etc.).

The openness offered by Jaiku makes it compatible with similar services, for example the famous Twitter (similar to Jaiku, but without mobile version available nowadays). The information updated on Twitter can be automatically retrieved by Jaiku unifying different networks and users.

### 3.2.2 MobiTip

MobiTip is a research project at the Swedish Institute of Computer Science (SICS). The aim of the study is to connect the terms digital, physical, and social environments. In order to achieve that, the study consists of the development and evaluation of a social mobile service for exchanging opinions among peers, allowing

1 *Micro-blogging is a reduced form of blogging that allows small text updates to be introduced and showed to a selected audience.*

users to introduce comments, recommendations and tips (hence its name) about everything in their surroundings.

MobiTip prototype has two different working modes. It may act in mobile peer-to-peer (P2P) mode, and exchange the comments among different users when they coincide in the same Bluetooth area. It also may act as a client-server solution based on the strategic situation of Bluetooth hotspots (the servers) in areas of interest, which collect and spread users' opinions when they pass close by one of these hotspots. This service provides the users located in the same environment with social awareness, acting the digital media as a connector between social and physical space (Rudström et al., 2005). The outcome of the study provides valuable insights to the mobile 2.0 discipline, connecting terms that are intrinsic to the nature of every design inside the field.

Nowadays MobiTip works exclusively on Sony Ericsson P910 mobile phones. This reinforces the idea that the landscape of mobile devices is extremely heterogeneous.

### 3.2.3 Push!Music

Push!Music is research project of Viktoria Institute (Sweden). It aims to assess the mobile setting as a social environment, through the design and evaluation of a music sharing system that allows users to recommend songs to other users in their surroundings. Users get spontaneous songs from others, if the musical taste of both users matches. With this system, the barrier imposed by the headphones is broken, allowing users situated in the same vicinity to listen to the same music, utilizing the mobile digital world as a connector within the social environment, instead of an isolation element (Håkansson et al., 2007).

Users upload songs to their devices, and they have the possibility to listen to them (as in a regular mp3 player). Users can also rate and tag their favorite songs, and recommend them to other users in their surroundings. The detection of other users in the environment and the transmission of songs, is performed wirelessy from a mobile device to another mobile device.

Push!Music currently executes in WiFi-enabled Personal Digital Assistants (PDAs), which makes the system usable in a large variety of devices (not brand or model dependent development, Windows Mobile operative system instead). The use of advanced technology such as PDAs provides a powerful platform that gives access to cutting-edge technologies like WiFi and big touchable screens. The only pitfall present in the use of this kind of mobile devices is the audience that they have: It is not very common for normal people to own these devices. Hopefully in the near future mobile phones will contain the flexibility and power of PDAs, allowing thereby mobile developments to be executed in any kind of device.

# 4 Methodology

This section presents the process followed aiming to answer the research question at issue, justifying the methods chosen for the software development and for the evaluation. Figure 2 depicts the process followed.

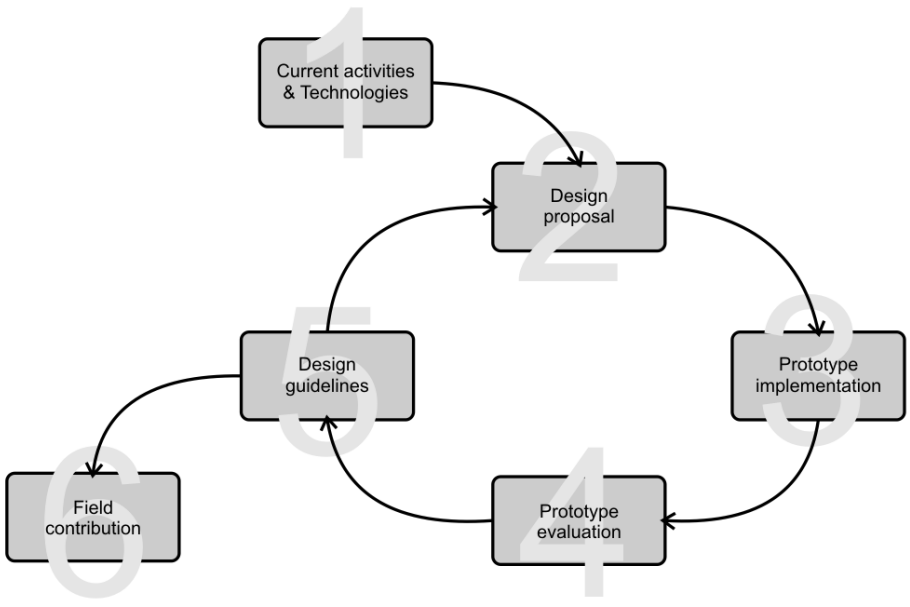


*Figure 2: Thesis process tasks*

1. ***Current activities and technologies:*** Following the practical approach indicated by informatics, the focus is to design IT technology use, and to generate innovations instead of mere improvements in the way people perform tasks. In this way, an empirical study of how certain secondhand advertising tasks are accomplished nowadays and how new mobile 2.0 applications are designed and evaluated was performed, trying to identify main requirements. It was expected to attain complete information to generate a description of the novel mobile artifact that could satisfy the users of previous services, enhancing the way they effectuate their advertising tasks.

2. ***Design proposal:*** Findings from the previous phase were materialized as a concept proposal. A set of informal requirements was satisfied, taking into account the social aspect of the software, and conceiving new concepts that would actually be used in real social mobile settings.

3. ***Prototype implementation*:** The chosen concepts were detailed and instantiated as an architecture design. The way to accomplish this was to perform a practical implementation of a tangible artifact, building a prototype that could be physically evaluated by people. In order to generate the software, a prototyping method was followed.

4. ***Prototype evaluation*:** The built prototype was tested in the real setting. Once the implemented application was presented to the participants of the evaluation, it was likely to determinate new problems and issues that were difficult to foreseen while designing. When presenting the case study to the participants of the evaluation, it was expected to gather important insights in form of criticisms and suggestions. Particularly it was introduced a type of case study where the emphasis was in the primacy of the context, showing ethnography method appropriateness for that matter.

5. ***Design guidelines*:** The feedback received from the user evaluation is analyzed and summarized as a set of design guidelines. These guidelines could be utilized to improve the previous designs, and to generate field theories and generalizations. In an iterative way, the users' response would return to the design, and improve the previous prototypes. However, since the time was the most relevant constraint in the process of development of the thesis, only one iteration was completed generating a prototype that was evaluated and provided expertise that produced a set of design implications and field contributions (next phase).

6. ***Field contribution*:** In order to provide new insights to the mobile 2.0 field, generalizations of the design implications were performed and provided as outcome.

In the next section, it is explained how the prototyping method was utilized, i.e. phase three (prototype implementation) is detailed. After that, it is presented how the evaluation method was used in order to collect evidence about the use of the prototype in the real setting.

# 5 Design method

As commented before, building a prototype it was expected to have a practical implementation of a tangible artifact that could actually be evaluated by people. In this section, the method followed to develop the prototype (adequately called prototyping) is described and justified. A comprehensive definition of the main terms is given, describing what type of prototype has been developed, and how the development process was performed.

## 5.1 Software prototypes

First, it is needed to establish the concept of a software prototype. Frederik Brooks (1987), defines prototype as a software system that emulates the inputs and outputs (interfaces) of the intended system, offering the main functionalities that it will implement. Typically prototypes do not capture exceptions, errors, or invalid inputs. Their purpose is to show the concepts implemented in a concrete manner, so they can be tested for consistency and usability. (Brooks, 1987).

Thus, a solution to secondhand advertising in the mobile setting was designed, defining the architecture of the system, which is instantiated as a working model that is evaluated and improved iteratively until it is finally satisfactory to perform the required tasks. As commented before, since in the study time was constrained and the objective was to suggest a set of design guidelines and theoretical contributions, one iteration was performed generating only one working prototype, which would give the first impressions about the mobile 2.0 field status.

The type of prototype that better adjusted to the requirements of the study was evolutionary prototype. The goal in this kind of prototypes is to generate a robust prototype in a structured manner, constantly refining it until a certain degree of satisfaction is met. This is based on the idea that making an effective and flexible design, implementing modest-affordable parts of the system, and evaluating them both separately and as a whole, will produce a high quality software. Therefore, the main aim using evolutionary prototyping is to develop an initial-incomplete implementation that is exposed to critical review, refining its concept through many versions until the desired product is obtained. (Sommerville, 1996).

## 5.2 Prototyping for the mobile setting

When prototyping, an explorative process is followed generating initial ideas that may evolve until a conceptually stable software is reached. Thus, initial studies of the context of use of the secondhand service may be explored, generating the first raw ideas through techniques such as brainstorming. Those initial ideas would lead an architectural design that takes into account the probable changes that might be introduced in posterior iterations. Evolutionary prototyping handles well the design of systems where the requirements are vague and dynamic (Sommerville, 1996). When the development of the prototype was first started, the specifications of the requirements and the concept of the software were unclear. Thus, an approach such as the traditional "waterfall" method would evidently be inappropriate. In opposition, prototyping technique is accepted as particularly suitable in situations where specifications are obscure or not well articulated (Gibson & Hughes, 1994).

Regardless of the software specifications, the most relevant properties of the mobile environment that determinate the chosen method are the lack of a uniform platform to develop mobile applications, and more important, the heterogeneous landscape that mobile devices conform. In addition, methods for designing and evaluating traditional desktop applications are not transferable to mobile services. According to Rudström (2003), there is a deficiency of methods that aid the design of nomadic tools on early stages. Even though mobile services are in many aspects similar to desktop applications, they have some peculiarities that might make difficult to apply traditional methods developed for general human-computer interaction. The most important characteristics of the mobile devices that make them different to desktop computers are the dynamic context of use and constrained user input/output mechanisms. Therefore, meanwhile new and more appropriate methods are developed and evaluated, prototyping provides an adequate way thanks to its fast development characteristics, its reduced time consumption, and low impact of integration (Rudström, 2003). Some authors have argued that prototypes provide a useful means of generating new designs early in the development process (Fuchs, 1992). Others have suggested that clients often choose features of immature prototypes without considering alternatives (Hayes and Jones, 1989). Regardless of the inconveniences, since the objective of the present study was not the development of a commercial application, instead the evaluation of ideas, prototyping was considered adequate to obtain knowledge about the use of mobile technology.

# 6 Development of the prototype

In this chapter the results of the process of developing the prototype is explained, detailing the concept of the solution, features, functionalities, user interfaces, and architectural design.

## 6.1 Background

First, before the prototype concept was established, it was needed to obtain the necessary knowledge about how people advertise secondhand goods nowadays. In order to achieve that, some of the services about traditional methods described before (such as newspapers and web 2.0 applications) were analyzed trying to identify some of their most successful characteristics. In this section an informal specification of requirements is explained, in order to give the needed background to understand the design and evaluation of the prototype.

During the development of the tool, it was desirable to perform the same tasks previously executed to buy and sell secondhand products, although in a different way (since the mobile environment holds special peculiarities). In the end, the desirable result should be at least as effective as previous traditional solutions. As commented before, the aim was to develop an innovative mobile service that adopts mobile informatics design guidelines, and more specifically that follows mobile 2.0 theories. Consequently, it was not suitable to adapt a desktop application (or a mixture of several ones) to the mobile environment. A new secondhand advertisement system was developed from scratch, taking advantage of the idiosyncrasies of the mobile setting.

After the most relevant systems nowadays were identified, and taking into account that they work basically as traditional advertisement sections of newspapers, it was noticed that what people required was a simple system to introduce small messages where they could describe the items that they desired to buy or sell (Craigslist is the best example). As consequence of the analysis of the existent systems, it was concluded that each announcement should contain fields such as a brief description of the item, a category so it is possible to classify each ad in the system, a price (maximum price in case of buying a product), and a way to contact the person that published the advertisement. Some online systems also provided means to show a picture of the article of trade.

Thus, users are able to add new advertisements that are stored on their mobile phones. Once Bluetooth is activated on their devices and the users allow the publishing of the advertisements to others in their surroundings, it is likely to propagate the stored announcements to other devices around (Bluetooth range is normally around 10 meters). The users also have to possibility to activate the discovery of other advertisements published, acting as consequence their devices as active searchers. While working on this mode, each X seconds (determined by the user), the device inquires the medium willing to detect devices in the environment. Furthermore, for each found device in the inquires, the handheld looks if the MobileMarket service is offered by the foreign device. If so, the foreign announcements are retrieved. In that moment they are compared, to realize if the local user desired the category of each advertisement, and reject or store each announcement as consequence. The users may choose the categories of advertisements in which they are interested on. For instance, they may select from a list elements *electronics*, *home appliances*, *toys*, etc. Each published advertisement belongs to exclusively one category, so when sent to other users, they can be filtered depending on the other users' interests (figure 3).


*Figure 3: MobileMarket propagation of ads based on users' preferences*

An important issue that the study considered is the audience of the advertisements. As commented before, newspapers have the property of being distributed in determined locations (a town, a country, etc.). Their most notorious pitfalls are that they just show each advertisement for a day, and that they are normally a pay-per-use service. The audience of Internet advertisement sites is normally the country of publication, but in some cases they can be reached from any location in the world. Therefore, issues with the logistics and payment of the articles appear. The costs

associated to delivering the merchandise and finding a secure way to perform the payment are the most important matters when the scope of the announcement is wider than a few kilometers. As consequence, people might feel that the process is complicated, avoiding the exchange of goods with other people using that way.

The mobile service designed provides a different way to exchange goods, solving partially the location issue. Taking advantage of the intrinsic characteristics of the mobile setting, which allows to establish connections among people situated on the same locality, it is possible to make others aware of our presence. As consequence, spontaneous trade of people's published advertisements can be performed, which automatically limits the scope of the announcements to those that wander around the same places. This produces a connection between the physical space and the social environment by means of use of technology. Traditional applications failed when trying to establish social connections in the physical space, requiring auxiliary ways to exchange goods (sending products to postal addresses and money to bank accounts). The mobile way to publish announcements in the user's surroundings avoids the necessity of using such superfluous logistic services, since people know that the receptors and possible interested people in their products have been in the same location and they probably live in the same neighborhood. Therefore, a face-to-face meeting can be appointed in order to exchange the merchandises in an inexpensive and safe way.

Nevertheless, the proposed system does not provide any means to perform the physical delivery of the goods and their consequent payment method. It is a mere advertisement system that allows the users to agree and choose the best way to execute the transactions. Indeed, in this case (as in many others), information technology is the bridge that connects people, providing a platform that assists users' tasks and makes them easier.

It must be noted that the final purpose of the produced prototype was to be evaluated by users. The first major difficulty in evaluating a mobile system is having a reliable system to evaluate. Therefore, since it is complicated to generate a complete prototype in just one iteration, this issue was accounted while performing the evaluation. Technological complications that the users informed were assessed consequently.

## 6.2 Concept of the prototype

The final intention of the developed mobile 2.0 service was to naturalize the way people advertise secondhand goods. The use of new mobile technologies makes possible to perform goods' trading as it was done in ancient times, when people used to barter goods. The digital mobile environment acts as a connector in the society, communicating people located in the same physical context. In this way, the aim was to generate an easy and usable artifact that do not annoy people while they accomplish they daily duties. The service was designed to act as transparent as possible for the users. Thus, simplicity was taken into consideration in every design decision.

The lessons learned from preceding theories and work were followed in the design process. Those ideas, (as presented in chapter 2) were inherited to mobile 2.0 from informatics, mobile informatics, and the WWW 2.0. Remembering and summarizing them, they consisted of: The design centered of the developments; designing mobile IT use; context awareness and consciousness of the mobile setting intrinsic properties; social participation; and the use of a standard and open platform.

There were two main factors that determined the design of the prototype. First, the task to develop itself, which settled the functionalities and features; and second, the technological environment where the task is developed, which defined the architecture of the system. Next subsections analyze how both factors were taken into account in the design process.

### 6.2.1 Functionalities and features

The navigation around the application is hierarchically organized. This organization is determined by the nature of user interfaces of mobile phones, which are restricted to menus and submenus that are easily navigable through the mini joystick. When the user executes the application, the main menu of MobileMarket is presented. As depicted in figure 4, the main menu shows the principal options of the program. The style, look and feel, and interaction means are determined by the implementation of the Java Virtual Machine on the specific mobile phone. Therefore they may be different in each handheld, although the same functionalities should be provided. For instance, navigation through the menus and submenus, and a way to exit the application might be using physical buttons or logical buttons represented on a touchable screen.

*Figure 4: MobileMarket main menu*

The navigation features normally found in mobile phones are followed, which allows the users to enter subsections and return from them using the back key (physical button) or a back option in a menu (logical button) associated with a selection physical button. Additionally, the structure designed for the navigation around the application tried to emulate the specific characteristics that mobile phones screens provide. For instance, the typical Short Message System (SMS) applications might look the same and have the same behaviors. So it was tried to keep consistency with other phones' applications, so the users feel familiar with MobileMarket from the very beginning they start interacting with it.

Figure 5 pictures how the different functionalities are organized hierarchically, hanging from the main menu of the application. The description of the different options is as follows:

- **Received ads:** Shows a list containing the advertisements that have been received from other users (figure 6). The elements already seen are presented

with a representative icon, so the users know how to distinguish between old and new advertisements.

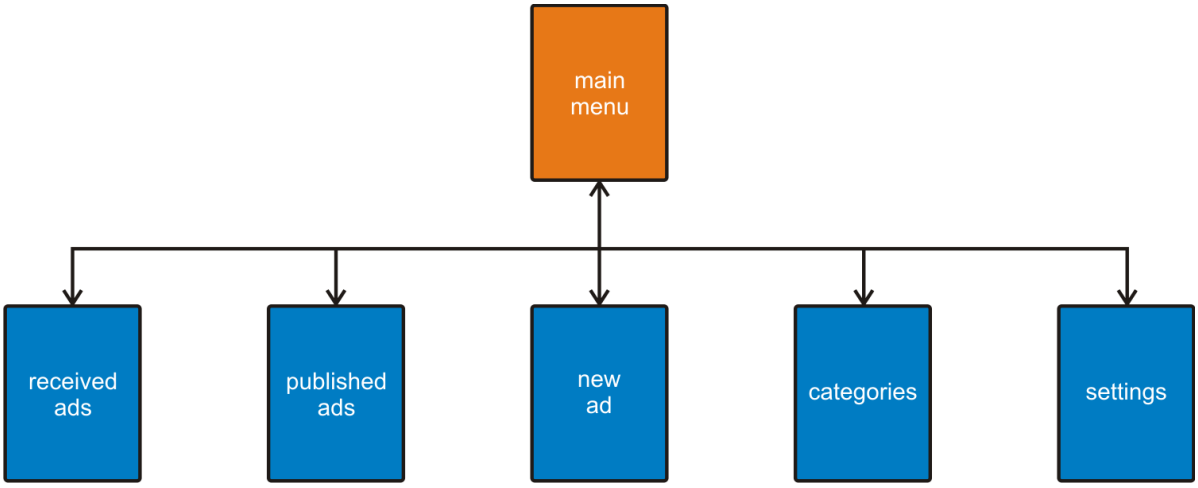


*Figure 5: MobileMarket navigation: Main menu*

- **Published ads:** Presents a list containing the advertisements that the users publish in a certain moment and will be sent to other users in the surroundings. When the users select to view an advertisement, either received or published, the information contained in the announcement is shown as in figure 7.

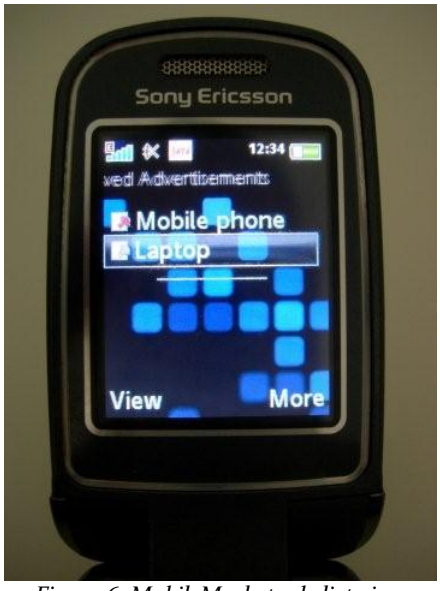


*Figure 6: MobileMarket ads list view*


*Figure 7: MobileMarket ad view*

- **New ad:** Allows the users to introduce a new advertisement that will be automatically published.

- **Categories:** Presents a list with a predetermined number of categories in which the users are interested. The users might select several categories from this list (for instance music and computer appliances), so they would only receive the advertisements from other users that fit into at least on of these preferred categories.

- **Settings:** Provides a set of options so the users might determinate the behavior of the application. Figure 9 depicts the diagram with the different options that might be configured.

Following the hierarchy of the application, when the users choose the option *new ad* on the main menu, a submenu with some suboptions is presented.

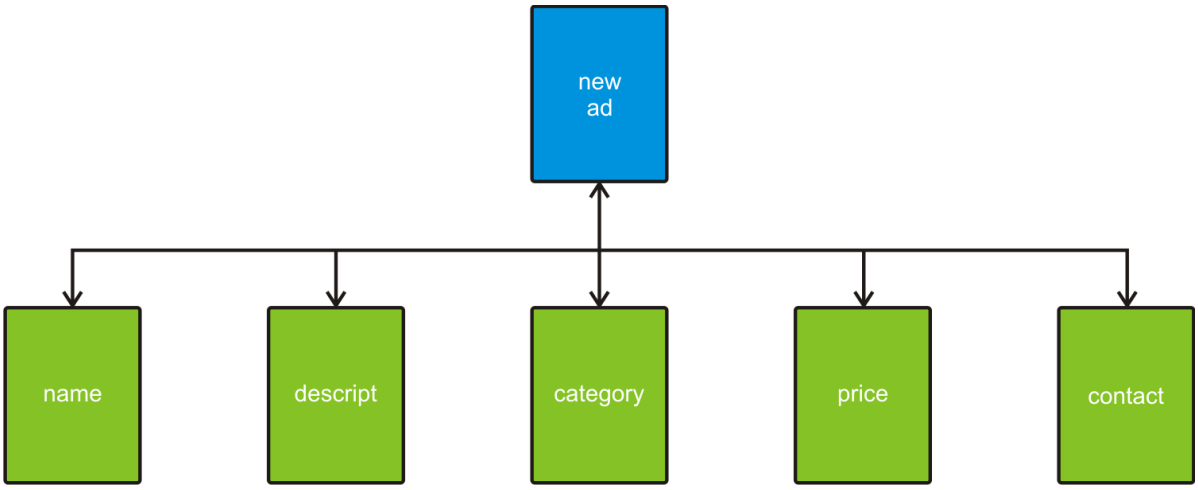


*Figure 8: MobileMarket navigation: New ad submenu*

- **Name:** Provides an input field so the users are able to introduce the name of the article about to be published.

- **Description:** Provides an input field so the users are able to introduce the description of the article about to be published.

- **Category:** Presents a list with the categories so the users might choose the one that classifies better the article about to be published.

- **Price:** Provides an input field so the users are able to introduce the price of the article. Since the application is no location constrained (it can be used in any country of the world), the currency is determined by the country where the application is utilized.

- **Contact:** Provides an input field so the users are able to introduce a way to be contacted by someone else that is interested in a published article. Several methods might be chosen depending on the user's preferences. For instance a phone number or an email address.

All the fields of the advertisement are required since it is considered that they contain the basic and necessary information to perform a purchase or sale. If the users return to the main menu before completing an advertisement, and then come back to add new ad option, the information that was previously introduced will be shown in order to be replaced or completed.

In addition to the main functionalities, and regarding the advertisements management, it is provided a way to configure the application. The users are allowed to change some options of the system selecting the option *settings* on the main menu.

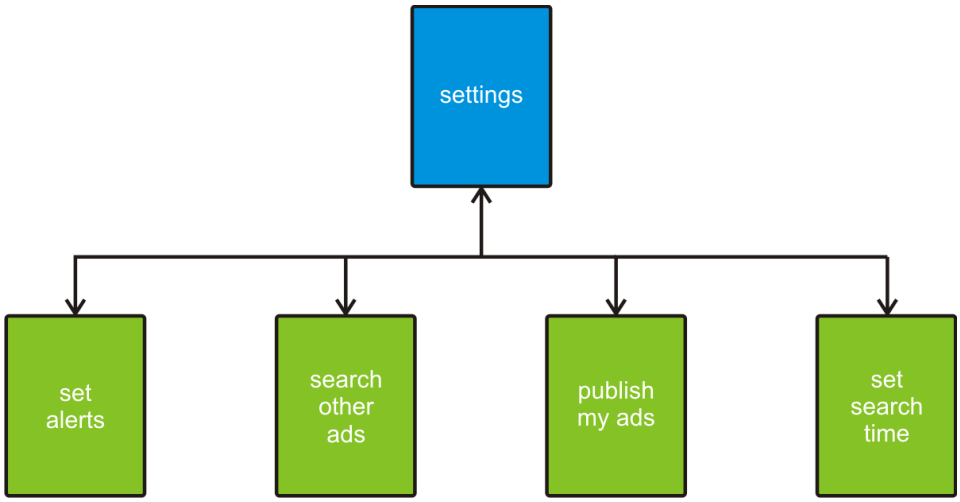


*Figure 9: MobileMarket navigation: Settings submenu*

- **Set alerts:** Provides a way to choose whether the users would like to receive an alert when a new advertisement is received or to silently store the messages to be manually reviewed (figure 10). The alerts normally depend on the preferences of the mobile phone, for instance a short sound and a vibration. A message is presented on the screen of the phone, which shows the number of unread announcements (figure 11).

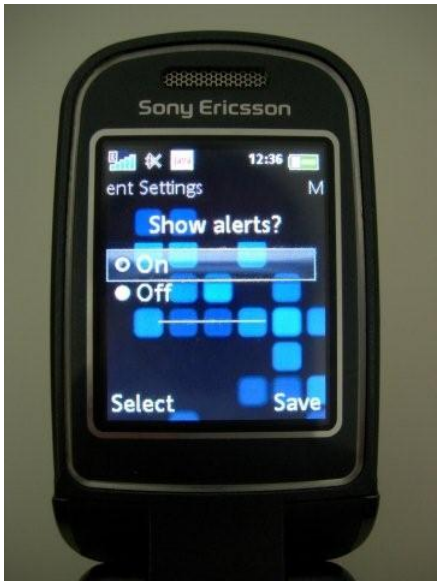


*Figure 10: MobileMarket alerts setting*

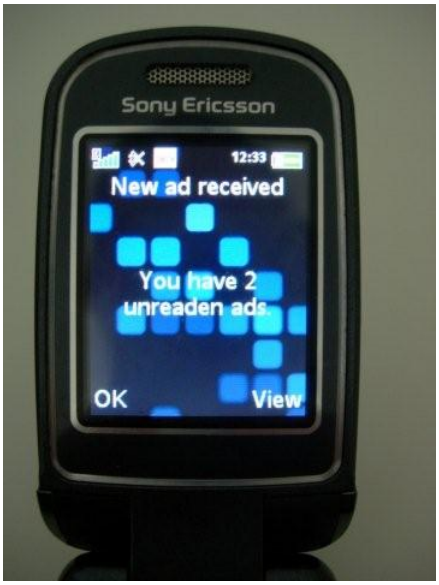


*Figure 11: MobileMarket new ads alert*

- **Search other ads:** Provides a way so the users might select either to search for other devices retrieving their ads, or to be a passive actor that will not scan for other devices and consequently will not receive advertisements from others.

- **Publish my ads:** Provides a way so the users might select to publish the local ads, so their devices might be found by others, and propagate their announcements as consequence. If this option is inactive, other devices will not find the device, and the advertisements will not be propagated.

- **Set search time:** Provides a way to configure the time between searches of other devices in the surroundings. This could be a way to customize the behavior of the system, giving the users the possibility to select a long time, which saves battery. On the other hand, a short time will utilize more battery (more searches in the Bluetooth medium), although the possibilities of finding other devices increase.

### 6.2.2 Technological environment

The technological environment was determined eminently by the type of mobile device selected as target group: Java platform compatible mobile phones. This technology was chosen since it is the most extended platform nowadays (check table 3). Other alternatives studied were Symbian and Windows Mobile platforms, which were discarded due to their reduced (but increasing) utilization in regular mobile phones. Additionally, because of the multi-platform characteristics of Java, the same

software is supposed[2] to be executed in any brand and model of Java-compatible handhelds, without the need of recompiling the code. Finally, the experience on that programming language that the developer possesses allows an agile and robust software in just one iteration in the development process.

| ***Platform*** | ***Market Share*** |
|---|---|
| *Java* | *~ 82 %* |
| *Symbian OS* | *~ 16 %* |
| *Windows Mobile* | *~ 2 %* |

*Table 3: Mobile platforms market share (mobiref.com)*

The development of a Java mobile application is normally performed using the Java Microedition (Java ME) Application Programming Interface (API) provided by Sun Microsystems. This API is specifically conceived to program lightweight applications that fit perfectly on the reduced characteristics of mobile phones. Java-platform mobile phones include a limited virtual machine that provides an abstraction layer to the hardware of the device. The most extended virtual machine in mobile phones is based on the implementation of what is called Connected Limited Device Configuration (CLDC) and Mobile Information Device Profile (MIDP), which together determinate the Java ME API to be utilized in the development. Applications developed following that API are called MIDlets.

The built prototype consisted of a MIDlet based on some characteristics of Java ME such as *Display* generic controls for representing the user interface (both showing graphical elements and acquiring user input), *Record Management System* (RMS) for the persistent storage, and *Bluetooth API* for the communications with other devices. All this was combined with the Object Oriented paradigm followed by Java, which offers inheritance, encapsulation, abstraction, and polymorphism, among others. Compounding these technologies and techniques it was possible to develop a mobile 2.0 service prototype in an easy and comprehensible way. Next section explains how these technologies were utilized in order to implement the previously related functionalities, introducing the architecture of the system.

2 *Some of the Java multiplatform issues are commented in the discussion section.*

## 6.3 Description of the architecture

The description of the architecture of the prototype follows a customized version of the process presented by Phillip Kruchten (1995). He proposed a way to separate the description in various views each one addressing the concerns of different stakeholders. Specifically, Kruchten proposed the use of four views (physical, logical, development, and process) plus one extra view that ties the rest together (scenarios). In the study, the model was customized due that Kruchten used a system-centered approach. In opposition, in the thesis the approach was user-centered. As consequence, a top-level description is provided simplifying the suggested "4+1" model of Kruchten in a "2+1" model. The superfluous views in the study are process and development views. The dismissed views provide an in-deep description of the architecture addressing mainly the concerns of the developers and other technical actors within a larger software development process. Hence, the views presented in this section are the physical view (in charge of presenting the topology of the system), the logical view (in charge of presenting the functionality), and the scenarios (in charge of presenting interactions among different objects).

### 6.3.1 Physical view

Kruchten's article defines the physical view as the one accounting the non-functional requirements. In this view, a top-level description is presented showing the communications among different devices.

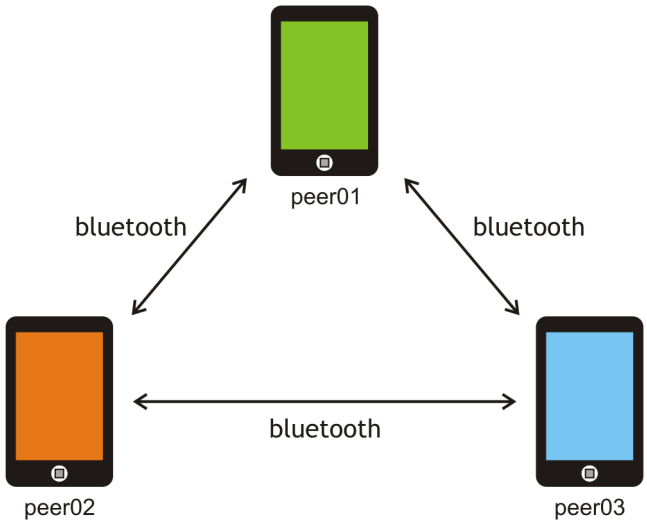


*Figure 12: MobileMarket physical architecture*

Figure 12 pictures the distributed nature of the architecture of the system. In fact, the application has not been designed just as a regular distributed system, but as a mobile distributed system where the connections with other peers are established through wireless technologies (as commented before, Bluetooth). Specifically, the design of the architecture describes a peer-to-peer pattern where each node possesses the same responsibilities in the system, i.e. each node offers services to other peers and uses the services offered by other peers.

Every device performs searches in the Bluetooth medium trying to discover other devices in the action ratio. The inquires are established through the Bluetooth Service Discovery Protocol (SDP) which returns a list of the devices that are connectible in the vicinity of each handset. Each device discovered is scanned searching for the services that it offers, and specifically looking for a MobileMarket compatible service. In case that MobileMarket service is found, a connection is established with the foreign device, acting the searcher device as client in the communication. In that moment, the server will send all the published advertisements to the client, and vice versa. In the same way, every device listens for incoming connections from other systems, acting as a content server. In order to provide this functionality, the service named MobileMarket is registered on the Bluetooth Service Discovery Data Base (SDDB), so the inquires of other devices can determinate the availability of the device for incoming connections.

### 6.3.2 Logical view

As defined in the Kruchten's "4+1 views" article, the logical view supports the functional requirements. Since in the study only a top-level degree of abstraction is presented, simply a first decomposition is established. As consequence, all the functional requirements cannot be identified in this view.

Figure 13 represents the logical view of the architecture. The architecture follows a Model-View-Controller (MVC) design pattern first described by Trygve Reenskaug (1979) at Xerox Park. This pattern separates the presentation of information to users (view) from the business logics (controller) and the data storage (model). In the study, a variation of the pattern was implemented, cutting the connection between view and model (being the controller responsible of validating user input). Therefore, the pattern degenerates in a three-layer architecture.

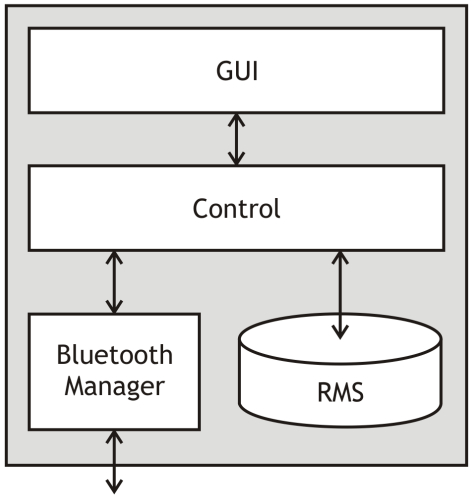


*Figure 13: MobileMarket physical architecture*

GUI component represents the view, Control represents the controller, and it is considered both the Bluetooth Manager and the RMS storage system as having the role of model of the MVC. The Bluetooth Manager is considered part of the model since it is source and destiny of information sending messages (containing the advertisements) to other devices. The responsibilities of each component are:

- ***GUI:*** Responsible of performing users' interaction with the system. It displays the screens that contain the elements such as lists, forms, etc. and captures the users' input.

- ***Control:*** In charge of controlling the business logic of the system, i.e. receiving the data from the GUI input, validating it, and consequently storing or sending it when necessary. It also provides the required information to be presented to the users, and collects the messages that arrive from other devices.

- ***RMS:*** Responsible of the persistent data of the application, it stores the advertisements published by the users, the ones received from other users, as well as the categories of the advertisements.

- ***Bluetooth Manager:*** In charge of the communications with other devices. It contains two main functionalities: It listens for incoming connections from devices that are searching; and it perform searches, trying to discover other devices in the surroundings in order to send them the advertisements stored locally.

### 6.3.3 Scenarios

This subsection presents some of the most representative scenarios that explain how certain dynamic operations and interactions are performed. The objective is to tie together the elements described in the previous views, showing how they match within the whole system.

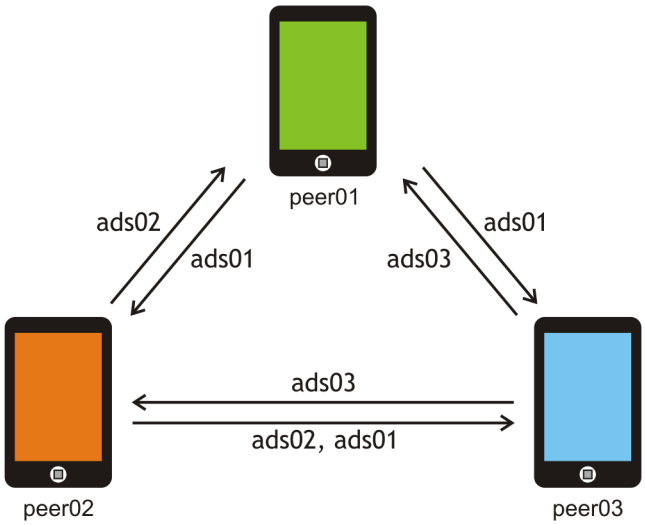


*Figure 14: MobileMarket ads exchange scenario*

The first scenario (figure 14) represents how the system propagates the advertisements published by each device. It also describes how the system might be used to propagate the advertisements that are rated by users so they can be redistributed from device to device.

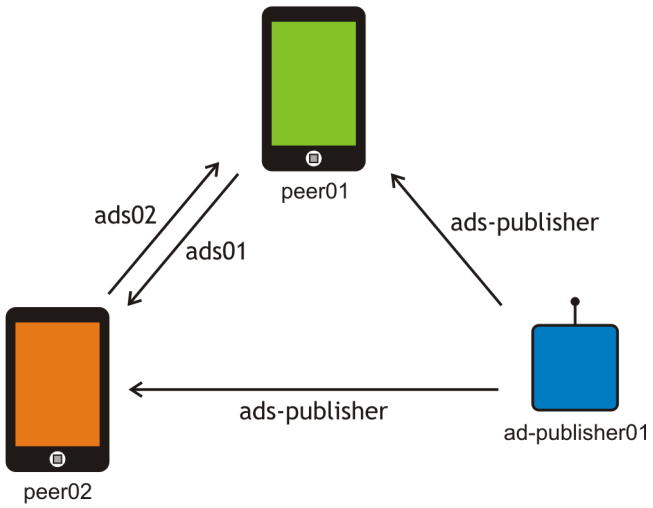


*Figure 15: MobileMarket commercial application scenario*

Another interesting scenario shows how the system might be utilized as a commercial advertisement system in stores. Bluetooth servers might implement MobileMarket service and publish offers or sales for their customers. When MobileMarket users pass by a server located in a store, if their mobile devices are configured to receive announcements that match the categories that are offered by the store, they could receive the publicity directly to their devices being aware that there is a store that supplies an interesting product in their surroundings.

# 7 Evaluation method

The final purpose of the development of the prototype was to carry out an evaluation, which provided important insights about particular issues difficulty foreseen while designing. So focusing the secondhand advertisement service as a case study and presenting it to a selected group of evaluators it was expected to receive relevant feedback as criticisms and suggestions. The way to collect this feedback was analyzing the use of the software by people, emphasizing in the context of use so important in mobile services. The data collection and its posterior analysis were undertaken through a qualitative research method, specifically ethnography.

## 7.1 Evaluating a mobile service

Regardless of the mobility of the object about to evaluate, the first issue that affects any research study involving the development of a prototype is the quality of the product. In the study only one iteration was performed generating a first stable software that suffer some constrains. The evaluation of the prototype was performed focusing in aspects such as interaction matters that the users experience when using the system, difficulties derived of collaboration among different users, and the problematic of using the system under unpredictable circumstances (Weilenmann, 2003). Occurrences of these issues were collected and analyzed, converting them in opportunities to improve designs of future versions of the prototype or new developments.

Previous studies failed to determinate how a good design should be, due mainly to their focus on technology itself. They did not take into account that in the end technology is used by human beings. There is a reciprocal relationship between social and technical aspects of all developments. As pointed inside informatics theories, technology does not exist excluded from the social scenario, which means that it is affected and affects the social situation. When developing technical services it is primordial to think beyond technology and consider the social context where they are going to be used.

Mobile services are considerably more complex than desktop applications regarding to the context of its use. They can be used by anyone, anywhere, and at anytime. This means that traditional evaluation methods such are the ones utilized in Human Computer Interaction (HCI) might not be perfectly suitable for mobile services.

Instead, evaluations must be carried out in real-world environments rather than in laboratory settings. It is needed to get familiarity with the domain of use of tools, understand how people develop tasks aided by technology, what they are doing, and what are their needs in their natural environment (Weilenmann, 2003). The goal of these context-aware evaluations is to determine how people use and interact with systems, what kinds of activities are engaged in, and whether the overall reactions are positive or negative (Abowd, 2000). Indeed, information technology necessitate the assessment of the social uses that it involves, and since that social use can be performed anywhere, ethnography shows to be appropriate to describe the happenings in its natural context. Qualitative methods offer more diversity in trying to explore and understanding the true phenomena than quantitative ones. Consequently, the explorative nature of case studies tied together with the descriptive nature of ethnography, provide a complete way to conduct studies with mobile characteristics.

## 7.2 Presenting a case study

Robert Yin (1984) defined the case study research method as an empirical inquiry that investigates a contemporary phenomenon within its real-life context, identifying its relationships with the environment, and in which multiple sources of evidence are used. The great strength of case studies is the richness of data that can be attained by multiple means (as commented before, in this case ethnographic techniques) when researchers are restricted to a single situation. This leaded the recommendation of the case study approach for novel disciplines and areas such as mobile 2.0. (Soy, 1997).

As noted by Bent Flyvbjerg (2006), case study research suffers of certain misunderstandings. The most important one that affects the development of the study is the claimed difficulty to generalize and the impossibility to develop theories on the basis of specific case studies. He corrects this misunderstanding arguing that generalization is suitable as result of an independent case study, always that it is complemented with alternative research methods.

In the study the generalization was supplemented by ethnographically collected and analyzed material. Results of the ethnographic approach to the field supported by observations, descriptive field notes, and an exhaustive analysis of the data, produced evidence of what was happening in the real world. As consequence, the generalization presented in the end of the study is based on evidence collected from the

development and evaluation of the social use of the produced service through techniques that are especially propitious for the idiosyncrasies of the mobile setting, such as the ones provided by ethnography.

## 7.3 Quick and dirty ethnography

Ethnography has existed since the first years of the 20th century inside the field of anthropology (Berg, 2006). It started to be utilized in Computer Science for the design of interactive computational systems after the publication of Suchman's article *Plans and Situated Actions*. More than any other study, the work of Suchman demonstrated the potential with which social science analysis through ethnographic fieldwork could contribute to the design and evaluation of information systems (Anderson, 1996).

Techniques described in ethnography such as participant observation and interviewing have proved to be especially valid and adequate while evaluating user interfaces (Elliot Sin, 1999) as well as in the requirements elicitation process (Hughes et al., 1995). Towards succeeding in projects within these disciplines, intensive fieldwork must be performed as described in ethnographic studies in social sciences. The purpose of fieldwork is to become intimately familiar with the domain under study, learning its language and characteristics (Berg, 2006). Indeed, detailed and descriptive notes from the visits to the field must be taken in order to generate raw data for later analysis (Harper, 2000). As noted by Anderson, ethnography is a particular analytic strategy for collecting and interpreting the results of fieldwork gathered very often by participant observation. Thus, ethnography not only describes techniques for collecting data, but different ways to interpret and to analyze the obtained data (Anderson, 1996). Furthermore, ethnography is considered to be both descriptive (detail of the observations is crucial) and interpretive (ethnographers must focus on determinate occurrences) (Hosking, 2006).

There are several reasons why ethnography has succeed in informatics related disciplines. These reasons are that its conduct is unproblematic, it requires little preparation, and no special expertise, which allows it to be easily used by non-sociological researchers such as software engineers, system designers or evaluators (Hammersley & Atkinson, 2007). Many systems have failed because the design pays insufficient attention to the social context of work, which existing methods for requirement elicitation mainly neglect to capture (Hughes et al., 1995).

The time required to obtain sufficient empirical data using ethnography in computer science related fields is not several years as some anthropologically oriented approaches suggest, but usually less than a month. This is especially true when using *quick and dirty ethnography* (Hughes et al., 1994).

Quick and dirty ethnography is a special adaptation of the social science method to the IT field, where brief ethnographic studies are undertaken to provide the designers with a general but informed understanding of the setting. A shorter time is spent doing fieldwork, although this method as Hughes et al. state, *"is capable of providing much valuable knowledge of the social organization of work of a large work setting in a relatively short space of time".* (Hughes et al., 1994).

Among the characteristics that the mobile environment presents and make ethnography propitious for this kind of studies, are the unpredictability of the context of use and the social interaction that people normally engage (Weilenmann, 2003). Since the evaluation element of the study is constrained in the extension of the use, the researchers cannot simply wander around trying to perform fieldwork. It is needed to set up a special environment where the interaction phenomenon will happen for sure. How this environment was set up, and in general, how the field was approached is introduced in the next section.

## 7.4 Approaching the field

As commented before, the first major difficulty to evaluate a mobile system is the fact that having a reliable system to evaluate is complex. This situation was accounted while performing the evaluation of the prototype developed. Technological complications that the users informed were assessed consequently. Some of the functionalities were not completely implemented, the error management could be certainly improved, and the stability was not as good as it could have been. These issues were taken into consideration while performing the evaluation.

The evaluation of the prototype was conducted by a single investigator that had just a little of experience in fieldwork, but was familiar with the development and the participants of the evaluation of the system. The aim was to collect a sufficient amount of qualitative-raw data, for its posterior analysis and interpretation. The power of the techniques provided by ethnography, such are intensive fieldwork

(limited in time by the quick and dirty variant), participant observation, and descriptive field notes, allowed to perform the user evaluation smoothly.

Fieldwork, which is normally conducted in situ, can be contrasted with laboratory research, conducted in a quasi-controlled environment (Gunzuk, 1999). In this way, the study was not either pure fieldwork, nor pure laboratory research. It was undertaken in a semi-real world set up, since it was impossible to find casual users interacting with the system (it would have been nice to have the system widely spread around). Therefore, it was needed to arrange a particular group of evaluators that possessed certain characteristics. It was desirable to reunite a closed group of young friends that could interact in a specific location and spend time together, if not everyday, at least several times per week. Another secondary desirable characteristic was that the evaluators had some familiarity with mobile technology and not only willing to collaborate with a research project, but also to use the secondhand advertisement software as the one developed for this case study.

The described environment was found in Fridhems student residence in Göteborg (Sweden). This is a middle size (around 75 studio-flats) building, with common kitchens, where a mixture of international and local students coming from different backgrounds, studying or not studying IT-related studies, use to spend time together almost every evening after school. Thus, the setting was adequate to carry out the ethnographic study of the service.

Several tenants were asked to participate in the study. A group of 5 persons between the ages of 21 and 28 years old were interested and were able to participate in the study. The first approach to the field permitted to install the software on the participants' mobile phones and explain the functionality of the application. After that, the novel users were left free to discover the possibilities of the system, becoming the researcher a semi-passive actor. It was important not to tell the users what, where and when to use technology. They were free to interact, analyze, play, and enjoy the software. Of course that when they needed assistance, it was given by the researcher.

Some fieldwork sessions were conducted after the first meeting. In total, 2 approaches to the field were performed, consisting each one of around 1 hour of intensive fieldwork. The meetings were conducted as focus groups, with the aim to collect

users' impressions after using the system for some days, and observing the use of the service “in situ”. The location for the reunions was in the common kitchens of the residence, where the participants felt comfortable with the evaluation. Between each meeting, 3 days of testing time was left so the users could get familiar and use the program by themselves.

Participant observation was the chosen technique while performing this approaches to the field. The evaluators knew that they were being observed, even though the researcher tried to make them as comfortable as possible, interacting in a friendly way and more important, trying not to show a different role that the assumed normally. Descriptive field notes accompanied by several keywords (marking special and interesting events) were written down. The interpretations, however, were recorded separately from raw facts in order to avoid subjective influences in the facts.

A way to involve the researcher into the field was publishing some fictitious advertisements that the participants in the evaluation would receive. In addition, the researcher's mobile phone sniffed the environment in order to receive the evaluators published advertisements. Performing this active interaction it was possible to attain extra knowledge about the use of the system that the subjects of the evaluation performed. Informal conversations were not avoided by the researcher, promoting small talks with the participants in order to collect the maximum amount of data as possible. These actions should not be considered as interviews since they were spontaneous and improvised.

After each visit to the field, the notes taken were completed and analyzed. Collected material was studied trying to identify interesting issues that could be investigated in posterior sessions. In addition, a classification of events and a previous interpretation were performed. These operations were done due to the massive amount of data that qualitative methods provided. In this way, the access to information and its analysis was easier, avoiding an overflow of information that could make the study difficulty affordable.

# 8 Results of the evaluation

In order to present affordable and understandable information, the huge amount of qualitative data obtained from the evaluation sessions was summarized and classified. In this section, raw collected data is processed and presented, although it is not interpreted.

The participants in the evaluation utilized MobileMarket for a week in their mobile phones, performing 2 group meetings to exchange impressions (where the actual ethnographic fieldwork was performed). In the development of the first meeting people was guided to discuss about the use of the application. This was performed in that manner since the participants were getting familiar with the software and the innovative way of interaction using their mobile phones. The second meeting was focused in the social and technological aspects of the service. Once the users were familiar with the use of the service, deeper insights were obtained about different peculiarities of the tool. Next subsections separate the observed data in the different themes detected in both meetings.

## 8.1 General impressions

The first impression that some participants related when the researcher was explaining the functionalities of MobileMarket, was that the application seemed to be a way for commercial companies to send them publicity directly to their phones. *"So this will allow companies to annoy me, sending unwanted commercials to my phone?"*, a user asked. Only after the system was completely explained people understood what is the final purpose and possibilities of MobileMarket.

The feeling that the researcher had after the user evaluation was that the participants enjoyed the experience. Some of them commented that the application was nice to use, especially because the fact of receiving advertisements meant that other "mates" where in the surroundings. That was particularly remarked by several participants, even though the main location where they were able to use the service, was while staying on the residence. Some of them declared that it would have been interesting that the software was more dispersed, so advertisements coming from strangers could have been received while wandering around (out of the building). The most surprising happening, that some of the participants experienced, was that they could

even receive announcements while being in their flats, thanks to the ability of the Bluetooth waves to go through walls and doors.

The participants pointed that MobileMarket was exciting to use when other users were around, but obviously, if nobody was in the surroundings there was no way to use the software. In that way, some of them related that they moved around trying to meet others, willing to receive new ads and trying to spread their own published ones. When performing the user group meetings, people seemed to enjoy the most the software. It was observed that users published some advertisements meanwhile the sessions were developed and they monitored their phones waiting to receive messages from others.

It was noted a slight difference in the behavior between people that normally sell and buy secondhand products using alternative traditional ways, against the ones that have never performed such task. The ones that are used to this way of trading, showed to be more critical with the system, and they seemed to take it more as a serious alternative for the tools they normally use. On the other hand, the ones that were less interested seemed to use the system as a recreation service that allowed them to interact with people in the surroundings.

The most gratifying event occurred when the researcher was informed that the system was actually useful. As consequence of the use of MobileMarket there were some real sells. Even though the participants knew each other, they never talked about selling stuff, which thanks to the use of the application started to happen.

## 8.2 Interaction issues

As consequence of the two fieldwork sessions, some issues regarding the interaction with the mobile device were observed. Some people stated that writing in the mobile phone was very uncomfortable and slow. This issue is something well known in the mobile HCI discipline. Writing the announcements in the tiny and incomplete phone keyboard was as annoying as sending SMS for some people. This is the reason why sometimes some people prefer to call the person directly, rather than sending a message. In this way, some participants stated that there was no alternative for contacting via voice a possible interested person in buying a product.

Another problem encountered was related to the behavior of the software. A participant wanted to lower the volume of the sounds of the alerts when a new advertisement was received. Since the participants were not technology-savvy users, and most of them have never installed third party applications in their mobile, they did not know that the program adapts its behavior to the general preferences of the device. The researcher explained the option to receive advertisements silently in case they do not want to be warned when new advertisements arrived, or to configure the phone in soundless mode.

The option of receiving alerts in the moment an advertisement is received was considered a good option by some participants. Nevertheless, some of them remarked that it could be annoying if there are several persons publishing interesting advertisements in the surroundings. In that case, alerts would produce not only sounds and vibrations in the users' pocket, but also occupy space in the screen of the device.

Regarding some of the functionalities of the software, some users informed that they did not know if the received advertisements were for products that someone was trying to sell or buy. This design issue was not accounted while performing the planning of the prototype assuming that advertisements are for selling products.

Even though the categories of interest introduced in the system while designing it were considered complete, a user pointed that they were insufficient. He suggested the possibility of adding personalized categories of advertisements to the application.

Some participants of the evaluation commented that sometimes the system hanged for some time. They did not know what to do in those cases. They related how they were pressing buttons and the phone did not respond, and it seemed to be totally dead. Only when the battery was removed they could start using their handset again.

## 8.3 Technological issues

From the very beginning of the fieldwork users complained about the fact that they needed to have Bluetooth activated in every moment they wanted to use the service. They remarked two basic consequences. The first one regards the battery consumption. People commented that the battery autonomy is an important issue that would make them even reject the use of the software in every single moment.

They wanted to save their device's energy, so in the moment they needed to use the phone to make a call or to send a SMS they could actually do that. The second issue pointed by some participants regards the radiation emitted by the extra radio communication. They did not understand that the power of the emissions of Bluetooth technology is around a hundred times less than the regular GSM or 3G networks.

Another technological issue detected in the moment the software was needed to be installed in the participants phones was the fact that, even though their devices were Java platform-compatible, the tool did not work on their devices. This issue limited the scope of the study to users that owned certain kind of phones, especially those belonging to brands such as Sony Ericsson and Nokia. Users owning a Motorola or Samsung mobile phone had to be rejected to participate in the evaluation.

Moreover, a technological constraint that affected some people was the fact that their devices did not offer Bluetooth connectivity. Old and low-range mobile devices do not incorporate Bluetooth technology to interact with hands-free accessories and other handsets. This restriction excluded some people that were willing to be part of the study but their technology was not ready for a mobile 2.0 service.

Regarding to some features of the software, some subjects reported that they would have liked the program to start automatically when turning on the mobile phone. The fact of having to initiate manually the program made some people to forget about it, realizing after some time that the program was not publishing or sniffing advertisements.

Furthermore, a small talk regarding the source of the messages, discovered that some people would have liked to know at least when an advertisement was received (it was commented that location would have being just perfect). With that information they expected to recall the place where it was retrieved. This is especially true when the users deactivated the option to show alerts when a new advertisement was received.

A participant remarked that it would have been interesting to have a way to see when their own advertisements were sent to someone in the surroundings. This could help to know the interactions that are produced without receiving new announcements. Having this option, the users pointed, they could have received extra information

about the spread of the published advertisements, and know the chances to sell each product.

## 8.4 Privacy and ethical issues

In the first session, when the software was going to be installed in the participants' handhelds, it was noted by the researcher certain distrust to the fact that someone else was going to install “something” in their handsets. Some people seemed to be very possessive with their so loved and personal mobile phone, since they were “losing” control about what was going to happen inside their devices. However, after the software was installed and working, and they tested the capabilities offered, that initial feeling of distrust disappeared, and the participants started to show a different face to their new “toy”.

After some journeys using the service, and because of the total immersion in the field that the research experienced (being one more participant of the experiment), it was observed that some users did not take seriously the service. Pervert advertisements from anonymous publishers were received. The content of the announcements were associated to categories that indeed did not describe their nature. In the field which purpose was to show a way to contact the publisher a fictitious name was introduced. Some other participants mentioned this fact, and they proposed to filter those unwanted messages in anyway.

This last related issue leads to the well-known Spam matter. The participants showed certain concern with the fact that commercial brands could use the system to bother them with unwanted advertisements. The possibility of commercial stores sending customized offers to the users of MobileMarket when they were out and about, was interesting for some of the participants, but others rejected totally that idea arguing that the system should be an underground and social connector.

# 9 Discussion

Refining and interpreting the obtained results, it was expected to have sufficient knowledge to state a reasonable solution for the proposed research problem, represented with the question: *"How can mobile applications that will succeed in contemporaneous society be developed?"*.

Concreting the problem into more affordable inquires, two question statements were drawn: *"What technological enhancements are necessary in mobile platforms?"* and *"What design implications are likely to follow to develop mobile services?"*. Next subsections deal with these inquires, providing a comprehensible analysis to the data collected and drawing implications regarding each one. In addition, an evaluation of the methods is performed determining the validity and reliability of the methodology followed in the study.

## 9.1 Mobile 2.0 technological implications

This section draws conclusions about the changes and improvements that are necessary in order to establish an adequate technological platform that will eventually lead to the successful development of social mobile applications.

### 9.1.1 Respecting the specifications of the platform

The chosen mobile platform for the development of the prototype was Java compatible mobile phones. The decision of using this mobile platform was taken due to the wider adoption of this technology compared with others, such as Symbian, Windows Mobile, and the brand new iPhone OS (check table 3). Perhaps Java-compatible devices are the most limited regarding to their resources. There are more and improved possibilities with other platforms, although for the development of simple services as the one produced in the thesis, Java was eligible and adequate indeed.

However, the development of the prototype for the above-said platform presented several issues. This platform is resource-limited due to the characteristics of mobile phones. Low performance, reduced memory, unusable user interfaces, archaic input devices, and a limited API are the main pitfalls encountered in this platform. The process of developing the prototype proved that this is indeed a tedious task. There are emulators the facilitate the labor of testing the software when the development is

undertaken. Nevertheless, the variety of devices that shape the landscape of mobile phones do not match with the characteristics of the provided emulators by Sun Microsystems (creators of the platform).

Those matters are the reason why the companies that produce mobile phones customized those emulators, creating ones that match the software implemented in their models. This fact has destroyed the multiplatform characteristics of Java and as consequence it is necessary to develop, test, and recompile the software for the specific characteristics of each implementation of the JVM. The results of these issues leaded to a situation in which MobileMarket prototype worked only in the newest models of Sony Ericsson and Nokia mobile phones. The user study demonstrated that other brands are totally incompatible with the software. From the designers and developers' point of view, these incompatibility issues make the development of innovative mobile 2.0 services difficult, affecting the quality of the results in detriment of the final users. It can clearly be stated that an effort coming from the companies that make mobile phones is necessary, in order to follow and respect the specifications of the software platforms when new devices are designed.

### 9.1.2 Awaiting for the adoption of improved mobile devices

Some of the issues detected while evaluating the prototype were related to HCI. Regular mobile phones suffer of certain constrains that new nomadic devices such as PDAs lack. Some participants in the evaluation reported matters when interacting with the mobile phone, which is mainly designed to make calls. The most important detected pitfalls were limited input mechanisms (small non-qwerty keyboard) and tiny screens (less than 3 inches). Regarding the software of the phones, because of the constrained input and output hardware, those limitations affect the services developed that are as consequence more difficult to use.

In the moment mobile phones reach more user-friendly user interfaces under a reasonable price, allowing the development of new user experiences through innovative input and output mechanisms, society will start adopting new habits related to use of technology. The aim is to relocate the stationary computer as the main way to access information, taking the technology where the people is, rather than bringing people to technology (Holmquist, 2007). In addition to improved user interfaces, autonomy is an important demonstrated issue for the participants of the evaluation of the prototype. New communication technologies add the need of

improvements in the autonomous lifetime of the devices, with less energy consuming components and longer-live batteries (Satyanarayanan, 1996). The best way to satisfy these requirements, is to provide mobile phones with characteristics that will complement desktop computers as the only way to access information.

### 9.1.3 Asking for persistent connectivity

As commented in the literature review, it might be established an analogy between what happened in the Web and what is happening in the mobile scene. The Web suffered a deep change, from one-way communications to interactive flows of information, from companies to users, from the static to dynamic, from closeness to openness, from the individuals to the socials, in the end, evolving from the Web 1.0 to the Web 2.0 (Barners-Lee, 2006). Nowadays the situation in the mobile services stage may be considered to be in its 1.0 (perhaps 1.5?) release. Telecommunication providers are the only ones taking advantage of the use of mobile technologies through the basic services of calling and messaging. No innovation has been introduced in the last decade (Capobianco, 2006). Only recently, thanks to the development of new technologies the scene is starting to be reshaped. Service providers are starting to bring broadband Internet access to the mobile devices through GPRS and UMTS networks. However, the coverage and prices of these services is far away from being something that can be affordable for the masses. The consequences of ubiquitous and persistent connectivity to the "network of networks" will collaborate with the displacement of the stationary computer as the only way to access information. In that moment, society in general will adopt mobile phones as their main technological device, and mobile 2.0 services will benefit of that fact. In order for this to occur, network carriers need to make an effort bringing ubiquitous, permanent, and affordable Internet connection to mobile devices.

## 9.2 Mobile 2.0 design implications

This section proposes a set of design guidelines for forthcoming mobile 2.0 developments and provides new insight to the mobile 2.0 discipline.

### 9.2.1 Providing informative feedback

The evaluation of the prototype revealed certain distrust to the fact that it was needed to install third party software on the participants' devices. Someone else was performing unknown operations inside their handset. They felt that they were losing

the control of their personal mobile device. Information about security and safety will help the user to feel comfortable with mobile 2.0 services. To attenuate the feeling of losing control, informative feedback about the operations that are being performed must be presented to the users whenever they require it.

### 9.2.2 Giving control over the degree of pervasiveness

Participants of the evaluation exposed that the idea of having control over the possibility to know or ignore when new advertisements were received, was essential. This option allowed people to use the system silently, collecting announcements that were saved to be reviewed later. On the other hand, people had the possibility to receive an alert when new advertisements arrived. This last characteristic is a way of social awareness, where people know that someone else is in the surroundings and offers products that could be interesting. Giving users the opportunity to decide whether to know about the operations of the system or let the service work silently, is a characteristic that mobile 2.0 services must provide.

### 9.2.3 Supplying means for social self-regulation of contents

A relevant finding of the social evaluation was related to the content of the received advertisements. Spam and other kinds of unwanted messages were exchanged, which annoyed some users of the service. As can be learned from the web 2.0, assessment of the contents that others publish through self-regulation means, such as ratings or recommendations, should be a must in mobile 2.0 services.

### 9.2.4 Opening the service

The success of the web 2.0 revealed a fact that needs to be learned in mobile services. Systems that are based on open standards and provide an API showed to be more complete and successful (O'Reilly, 2006). The main advantages that openness could provide to mobile developments are possibility to create alternative applications, compatibility among different services, option to outsourcing parts of the developments, sometimes more secure systems, and in the end, progress based in competence, collaboration, and shared creativity. As can be learned from the web 2.0, following open standards and providing an API for 3rd party developments, will lead in mobile services that are more likely to succeed.

### 9.2.5 Requiring real-life and social evaluations

The social evaluation of the prototype revealed facts that were difficulty foreseen when designing it. Some of the issues identified would have been impossible to detect if, instead, an assessment in a controlled-environment would have been performed. When people utilized the prototype in uncontrolled settings, unexpected occurrences were detected (Weilenmann, 20003). Reapplying these new insights to the design of MobileMarket service would improve the degree of satisfaction of the users. Methodologically collected and analyzed empirical data from social and real-world settings, reveals extraordinary occurrences that supply important insights about how would be possible to enhance the quality of mobile 2.0 services.

### 9.2.6 Designing for social mobile IT use

Informatics, introduced by Dahlbom (1996), provided insights about designing IT use. Instead of focusing on technology itself, software is something that has to be designed for its use in real-world society.

Mobile informatics, introduced by Dahlbom and Ljunberg (1999), follows the contributions of informatics and establishes theories and methods to design innovative mobile services. Main concerns are the peculiarities of the mobile setting such as context awareness and technological constraints.

Last, social phenomena showed the need of digital support in order to satisfy the interaction necessity. The web 2.0 provided empirical insights about the standard platform that supports social collaboration (O'Reilly, 2005).

Innovative mobile 2.0 services, as depicted in figure 1, should take under consideration the theories, methods, and experiences of these related fields, in order to be successful in modern society.

### 9.2.7 Proposing a new taxonomy for mobile services

As consequence of the evaluation of MobileMarket and other existing mobile 2.0 services, it was noted that they clearly followed certain architectural patterns in the way they communicate with the world. Some of them presented total independence from fixed networks, some other presented total dependence, and some others behaved in a mixture of both. It can be said that the mobile services follow the next classification based on their interaction characteristics:

- ***Pure mobile services:*** This category includes nomadic services that take advantage of the intrinsic characteristics of the mobile environment (for instance mobile 2.0 services). The main properties of this type of services are localization-based social interaction and context awareness. The establishment of connections with other devices situated in their surroundings can be performed through ad-hoc wireless connections. The software architecture used by this kind of services is peer-to-peer.

- ***Pure network-dependent services:*** This category includes nomadic services that have the necessity of an infrastructure in order to present useful information to the users. The main network that might provide that needed remote information is Internet, and more specifically the Web. However, even though Internet could be the most relevant source of information, there could be others. For instance hotspots situated in different locations (disconnected from Internet), might provide information about events occurred in that specific place. The establishment of connections with remote servers can be performed through infrastructure wireless networks. The software architecture used by this kind of services is client-server.

- ***Hybrid mobile services:*** This category includes nomadic services that can act as both of the previously related categories. They might need of the access to a remote server situated (or not) in their surroundings (acting as a network-dependent service), or connect to devices located in their vicinity (acting as a pure mobile service).

From now on, it is suggested to consider mobile 2.0 appliances only the ones that take advantage of the mobile setting, i.e., applications that need information about the users' context to offer their services. Accessing the web from a mobile device should not be considered a pure mobile service, but a network-dependent service instead (for instance mobile web 2.0 services). Hybrid services, depending on infrastructures and context awareness might be considered as well mobile 2.0 services, and will be the ones that will be more popular in a near future. Examples of pure mobile services are Push!Music and MobileMarket. Examples of pure network-dependent services are the denominated mobile web 2.0 services. Examples of hybrid mobile services are Jaiku, MobiTip, and MobileMarket that can act as a hybrid service, when commercial stores provide offers to the devices in the surroundings through Bluetooth hotspots.

## 9.3 Evaluation of the methods

In order to develop and evaluate MobileMarket application, prototyping method was selected for the software development and qualitative research methods for the evaluation.

Regarding prototypes, as commented previously, they are constructed in an iterative way, improving the products until a degree of satisfaction is met. Since in the study only one iteration was performed, producing as consequence a first evaluable prototype, it is considered that it was not a totally usable artifact in the real world. In addition, prototypes are often based on unreliable and untested technologies. This, tied together with deficiencies and errors often committed in the design and implementation phases made the evaluation difficult for some participants. These facts, could produced inaccurate results, which impact in the final conclusions are to be determined. In this way, it is considered that the validity of the study could have been affected negatively.

Qualitative research methods, as the case study accompanied by ethnographic fieldwork, were chosen in order to elicit a better understanding of the users and their practices when interacting with the prototype. A proper ethnographic study takes an excessively long time to be a feasible in the IT field. This is the reason why a variant such as quick and dirty ethnography was utilized. Even though this method has demonstrated validity in other IT research studies, the limited resources of the study produced perhaps a too shallow immersion in the field. In addition, only a small sized sample of the population collaborated in the evaluation. The representativeness of that sample could be improved choosing randomly a larger number subjects within a scope, although since the population was not based in technology-savvy users it could be considered valid.

Another issue that must be considered regarding the evaluation, is the fact that the participants were friends of the researcher. This could influenced the way people behaved and used the system, avoiding totally honest answers in the small talks, which could produced wrong data. Additionally, some participants showed a lack of interest in the kind of service offered by the prototype. This fact could affected the quality of the data attained, generating as consequence invalid conclusions. It is considered that the importance of this kind of generated data is relatively low,

providing however other insights about the behavior of not interested people using the system.

The inexperience of the researcher in research itself and fieldwork concretely, could have influenced the way data was collected, producing biases based in subjectivity and prejudices. Other researchers could have participated in the evaluations, providing different points of view that would have improved the objectivity of the observations and their posterior analysis. Additionally, the conclusions drawn were based on the results of a single experiment. Further investigation is needed to confirm them and establish the limits of their application in the field.

In the end, in order generate valid and generalizable conclusions, it would have been needed not only more ethnographical sessions, but also a larger group of participants that would have been used the service for a longer period of time. Only then, completely valid conclusions about the current opportunities of social mobile developments could have been drawn. The study was strongly constrained by a lack of time that clearly affected the quality of the performance, and limited the analysis of literature and related applications, and the usage of the methods to produce and evaluate the prototype. Further iterations on the presented research cycle are recommended in future studies, improving the prototype and reevaluating it ethnographically in order to produce new conclusions and insights. However, the study gives a good starting point for bigger researcher projects, providing some insights that may be accepted to collaborate with the maturity of mobile informatics and more specifically mobile 2.0.

# 10 Conclusions and future work

Based on the analysis of related literature and systems, the development of a social mobile (mobile 2.0) prototype, and the real-life evaluation of the application, the study gathered sufficient evidence in order to:

- Propose a *taxonomy for mobile 2.0 services* based on how the interaction among several systems is performed. They can be classified as: Pure mobile services, network-dependent services, and hybrid services.

- Suggest a set of *design guidelines* to produce successful mobile 2.0 developments: Provide feedback of the operations occurring, give control over the degree of pervasiveness, supply means for social self-regulation of contents, open and API for 3rd party developments, perform real-life evaluations, and design for social mobile IT use.

- Produce a set of *recommendations and requests* necessary in order to establish the needed technologies and support for the development of successful mobile 2.0 services: Respect the specifications of the platforms, await for the adoption of improved mobile devices, and require persistent connectivity.

The proposed taxonomy collaborates with the maturity of mobile 2.0 discipline, providing a way to classify mobile services, which assists the elicitation of architectural and infrastructure requirements. In addition, the contributions of the design guidelines aid the development of innovative mobile services, taking under consideration not only functional facts, but also very important social aspects of the designs. Last, the relevance of the recommendations and requests lies in the fact that collaboration from all the IT industry is necessary. In the end, the implications of the study provide a new approach to develop mobile 2.0 services that are more likely to success in contemporary society.

The social success of mobile services will lead to the second IT revolution (after the web revolution), with the consequent landscape of an always-connected society, where potential interactions with other subjects and objects will reside in each person's pocket. The thesis aimed to collaborate to reach that stage, providing a small but valuable contribution to what will hopefully occur in a near future.

Although, intensive work and further research is necessary in order to produce advance. More studies related to mobile informatics and mobile 2.0 are required to improve the maturity of the disciplines, developing more innovative social mobile services and networks, evaluating them in real-world settings, and providing consequently new insights and theories to the state-of-the art. Ethnography can play a relevant role within new studies. We have to remember that technology is used by people, and that should be the last objective of every design: Generate innovative artifacts that will make society advance. However, these tasks cannot be performed only by researchers. IT industry have to collaborate to depict the future of technological society by means of providing mainly resources such as technologies and knowledge. In the end, we all have to work side by side pushing in the same direction, aiming to improve human beings quality of life through the use of technology.

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# Appendix A - Ethnographic field notes

Due to the big amount of data generated in both ethnographical sessions, and more specifically, due to the superfluous data collected, this appendix presents excerpts of the most relevant field notes that generated usable knowledge about the use of the service. Since the jotted-down field notes were incomplete, unordered, composed of keywords in the most of the cases, over descriptive in other cases, and in the end, it can be said that they were messy, they were rewritten in order to make them presentable and understandable.

## Session 1 – Göteborg, April 8th, 2008 ~19:00

The objective for the first ethnographic fieldwork session is (a) introduction of the objective of the study to the participants, (b) the installation of the software in their mobile phones, and (c) explanation of the functionalities of the service.

All the participants have arrived to the common kitchen on the top floor of the residence. The ambient is relaxed since some of the participants lay down in couches, and some others in chairs. All of them (including the researcher) are around a coffee table. All the participants have their mobile phones, some of them hold their devices in their hands, and some of them have left them on the table. The researcher holds a laptop, in order to transfer the application to the users and to write down field notes. However, the computer is situated in such a way that the participants cannot see the screen. The objective is avoid influences and gossips about the field notes.

One by one, the researcher proceeds to transfer the *.jar* file containing the application to the participant's phones, using Bluetooth. Meanwhile, the participants seem to ignore the development of the meeting, since they are talking about other trivial topics. The researcher goes one by one, asking for the name of the phone, for the activation of Bluetooth, and for the users to accept the incoming file. The first subject shows certain distrust when the researcher asks to activate Bluetooth, and accept the incoming file. Obviously she is conscienceless about the needed of installing software in her mobile phone. Perhaps, the social pressure due to the fact that the rest of the participants are waiting, make her accept the operation. The objective of the study is introduced to the participants, meanwhile the installation of the software is performed.

An exceptional case is found when a subject prompts indicating an error after receiving the application in his device. Indeed, the screen of the Motorola handset shows a undescriptive message “Error installing the application”. After trying once again, and receiving the same message, the researcher tries to recompile the program in the laptop, limiting some of the options of the JVM. After trying two more times, it seems to be impossible to install the software in that mobile phone. Consequently, the user is excluded of the evaluation, although, he stays in the room showing certain resignation. Meanwhile this matter is happening, the rest of the participants still talking about other topics; they don't seem to be interested in the study.

As consequence of the inability of installing the software in Motorola phones, another user is relegated of the study. Later in the meeting the researcher checks how a similar problem happens, this time with a Samsung handset. The software worked just fine in Sony Ericsson and Nokia mobile phones. In total, five participants have that kind of compatible devices. The researcher is a bit disappointed with the fact that some of the potential participants cannot be part of the evaluation, but the study must continue with the rest of the subjects.

The researcher proceeds to explain how the software works. The first impression a user shows, regards Spam. He interrupts: “So this will allow companies to annoy, sending me unwanted commercials to my phone?” A short explanation of the functionalities of the software relaxes the concerned user (and the rest of the participants). A small discussion is generated as consequence, and some participants ask questions to the researcher. Specifically interesting is the fact that a user shows regarding to need to have Bluetooth on in every single moment. She seems astounded. She explains that she wants to save her device's battery to talk with her friends instead. The researcher explains that it is true that they are going to note a decreasing in the time their batteries last, so they should charge them more often. Some users show skeptic faces about the software. Following the discussion, another participant asks: “What about the radiations that Bluetooth emits?” Some of the participants laugh. The researcher explains that, even though it is true that the device is generating extra emissions, these Bluetooth signals are around 100 times less powerful than the regular mobile phones radiations. More skepticism is observed in some of the participants. The evaluation task is more difficult than it was previously expected.

The researcher continues with the demonstration, and shows the audience how a new advertisement is added to MobileMarket installed in his handset. The participants are asked to state their phones, expecting the arrival of the announcement. After several seconds (almost a minute, which seemed to be more) some handhelds start showing the alerts (beeps and vibrations are noted) of new received announcement. This fact excites some users. They seem very surprised with the fact that the system actually works. They start adding test advertisements, and in general using the application. The researcher tries to occupy a second place, and participate in the session as a mere observant. Advertisements start arriving to his mobile phone. People seem to start enjoying the service, they use it as it was a game.

One participant asked the researcher: "Something I wander, is if the received ads are for products that are for sale or to be bought…" Indeed the researcher (that acted as well as designer and developer), didn't take under consideration that requirement. It was assumed that people just wanted to sell products. This fact is explained to the participants, so they can assume that the ads they publish and receive are for selling goods.

The rest of the time of the meeting is spent as spare time for the participants to use the software. They are ask to use the service for 3 days, with the aim of discover any kind of issue, and trying just to use the program and enjoy the experience. In addition, they are encouraged to take the study a bit more seriously.

## Session 2 – Göteborg, April 11th, 2008 ~19:00

It is Friday evening. The participants agreed to celebrate the last meeting this day, even though the most of them want to go out. So having a reunion before getting ready to party does not seem a problem for anybody. Hopefully the results are not affected. The objective is collect the experiences of the last few days.

In the session, exclusively the participants of the evaluation are present. The ambient is cozy and familiar since only six persons are meeting. The researcher asks in general about how was the experience last days. The participants show excitement about the use of the application. "It was very nice". Someone stated. "I even receive advertisements from ParticipantX when staying in my room!". They experienced the situation of receiving and sending advertisements even though they were not in the same physical space. Bluetooth is enough powerful to go through at least one wall.

A user of MobileMarket indicates that he sold something as consequence of the use of the system. He published several ads, one of them for selling a book. It was received by other participant that knew of a friend that was interested in the same book. So they agreed to perform the sale. The publisher of the advertisement seems very happy about this fact, and the rest of the participants look very surprised. It seems that they did not expect the system to be used effectively. To be honest, the researcher did not think about this kind of actions, even though they are the final purpose of the development. So the service is actually useful!

Something to remark shows up. A participant comments that the system hanged up, and there was no way to reuse the phone until he removed the battery. He states that he tried pushing all the buttons, but no response was received. "The phone was totally dead…" The researcher explains that since the program is an initial prototype, this kind of failures should be habitual. They would be analyzed and fixed in future versions.

One participant comments a fact that the researcher experienced some days ago. Advertisements selling inappropriate products were received. Indeed, information about selling an *erotic item*, classified in the category of *toys*, and sent by an anonymous publisher has been received by some users (including the researcher, who was performing some participant observations). All the participants laugh. They do not think about the possible consequences of this fact.

The session continues with some participants presenting different issues: Limited categories, start the program automatically when the phone is turned on, timestamps with the received ads, in the end, several functional requirements are discovered. Future developments of the prototype are going to be very complete. The feedback received is very comforting for the researcher. Observing the users utilizing the system provides insights about its actual use, perceiving the researcher differences between people. Some of them seem to be more serious and interested. A small talk, discovers that those are the users of other alternative web secondhand advertisement tools. In the end, the participants show gratitude because of the good experience, and they say that they will still use the system (although, the fieldwork finish now). The researcher thanks them, offers his services for help in the future, as well as the possibility of providing further versions of the software when improved and released.